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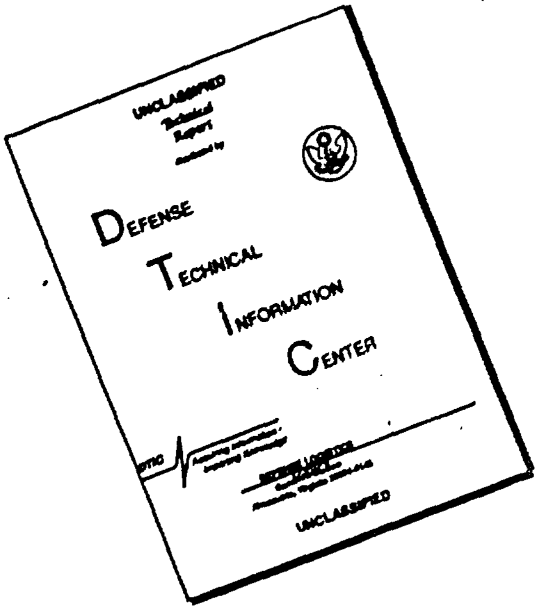

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GEOLOGY OF THE BASEMENT COMPLEX OF SOUTHEASTERN NEBRASKA, NORTHEASTERN KANSAS AND VICINITY

James W. Skehan, S. J.
Department of Geology
BOSTON COLLEGE

Contractor: Trustees of Boston College
Chestnut Hill 67, Massachusetts

Contract No. AF19(628)-1622

Project No. 4610

Task No. 461001

Scientific Report No. 1

July 12, 1963

Prepared for
Air Force Cambridge Research Laboratories
Office of Aerospace Research
United States Air Force
Bedford, Massachusetts

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ABSTRACT

This area is underlain by a great but variable thickness of stratified rock and granite ranging in age from Precambrian to Recent. The Precambrian rocks consist of granite and metasediments which have had a complex history. The upper surface of the Precambrian forms an irregular faulted ridge, the Nemaha Arch. In Pawnee and Johnson Counties, Nebraska, the Precambrian surface, which here is granite, rises to as much as 539 feet above sea level and in Nemaha County, Kansas, to as much as 588 feet.

The Nemaha Arch is cut by a major zone of fracturing, the Humboldt fault zone. This fault zone has undergone recurrent earthquake movements from Precambrian time to the present with the rocks east of this fault having been downthrown at least 2,600 feet. Geophysical data indicates that the Precambrian rocks of Kansas and Nebraska may be essentially a continuation of the sequence in the Lake Superior region.

All available geological and geophysical data, including deep resistivity studies, indicate that the Precambrian basement complex is unsuitable for both deep underground communication and deep underground facility installation.

GEOLOGY OF THE BASEMENT COMPLEX OF SOUTHEASTERN NEBRASKA, NORTHEASTERN KANSAS AND VICINITY

Introduction

The area of principal interest in the present study is southeastern Nebraska, northeastern Kansas and parts of adjoining states. The purpose of the study was to compile as much pertinent published and unpublished data as possible on depth to the basement complex and on the nature of the rock types of which the basement complex is composed. Structures in the basement complex rocks, such as faults and other features which could have a bearing on engineering problems, are of special concern. Insofar as possible any data relating to average conductivity or resistivity values of the basement complex and the overlying mantle of strata has been included. This kind of data however is extremely meager but certain features have been outlined by which a qualitative estimate, however poor, may be arrived at.

Figure 1 is a map of the area of general interest. This map was compiled from the latest available topographic contour maps of the United States Geological Survey on scale of 1:250,000 or one inch equal to approximately four miles and having contour intervals of 50 feet with supplementary contours at 25 foot intervals. The following maps served as the base for Figure 1: the Sioux City, Fremont, Omaha, Nebraska-Iowa quadrangles; Lincoln, Nebraska; Fort Dodge, Iowa; Nebraska City, Nebraska-Iowa-Missouri; Manhattan, Kansas; and Kansas City, Kansas-Missouri quadrangle maps.

Principal Sources of Data

Of the published data the most significant references have in general been those published by the Kansas and Nebraska State Geological Surveys. A list of references is presented at the end of this paper and includes the most significant papers relating to the problems at hand. Published data on the basement complex rocks is extremely sketchy and most direct evidence is at present unpublished.

The most fruitful sources of unpublished data bearing upon the problems at hand were the files of the Kansas State Geological Survey and the wide knowledge of this subject possessed by Mr. Virgil B. Cole, Consulting Geologist, Wichita, Kansas and Chairman of the Kansas Basement Complex Committee. Edward G. Lidiak, Research Fellow of Balcones Research Center, the University of Texas, Austin 12, Texas, is currently making a study of the Precambrian of Nebraska and has furnished valuable data to the present study. Dr. Donald H. Hase, of the Iowa Geological Survey, provided a certain amount of data for the Iowa region where such data was prior to this point essentially non-existent. Many other individuals and organizations are important sources of unpublished data and in future studies should be consulted for further information. In Appendix 1, a partial list of such groups and individuals is presented with expectation that they would be able to provide certain amounts of significant information to future studies.

Topographic Setting of the Area

The Omaha region of Figure 1 lies largely within the Dissected Till Plains region as defined by Fenneman (1938, Plates V and VI and pages 588-600). This area is essentially that of the exposed Pleistocene Kansan glacial deposits laid down within the past

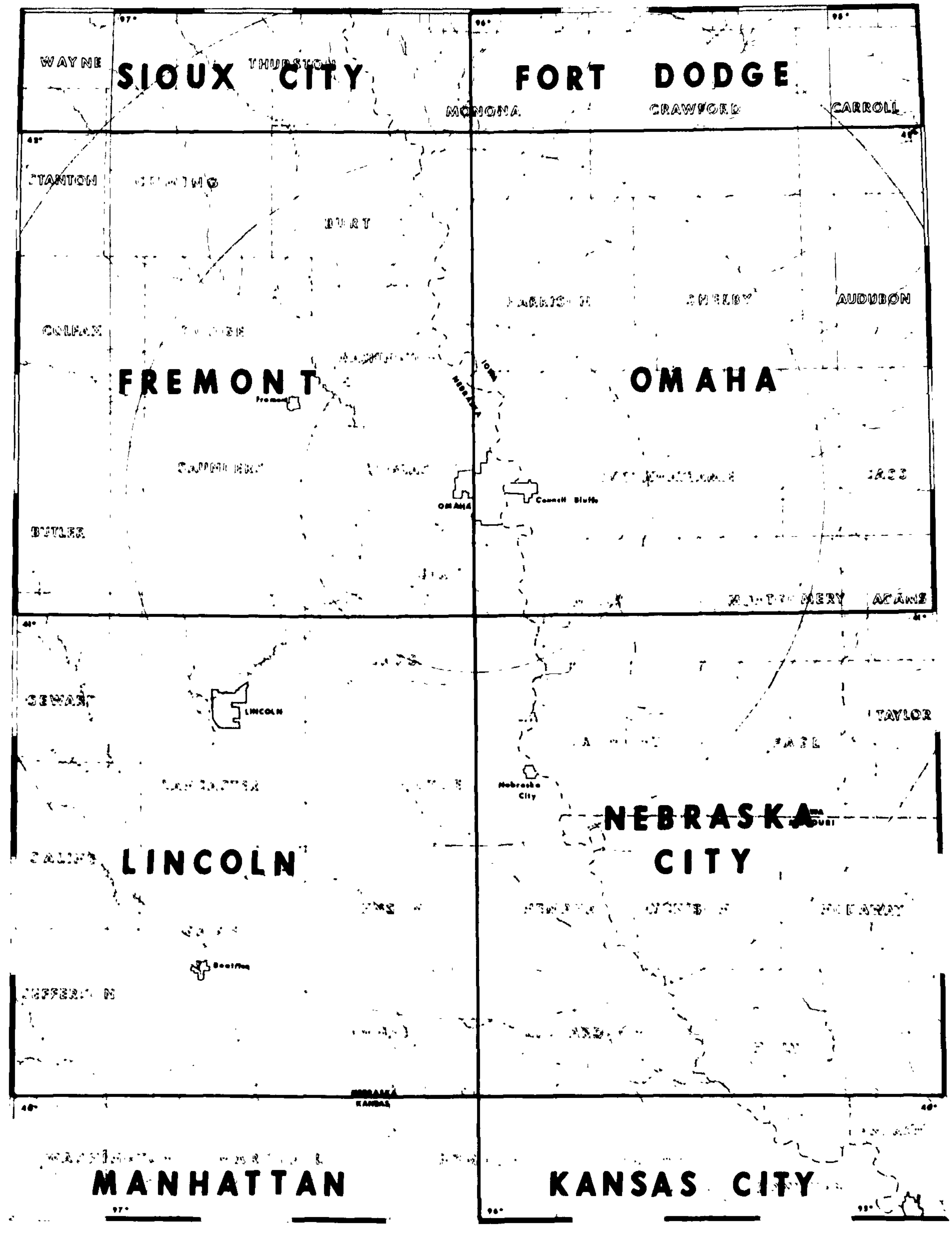

FIG. 1. INDEX TO TOPOGRAPHIC MAPS FOR OMAHA REGION ON SCALE 1:250,000

million years. This general section is a nearly flat Till Plain having gently rounded slopes with a present relief of 100 to 300 feet or more. It is covered by loess, generally a few feet deep but locally increasing to 30, 50 or even as much as 90 feet. The topographic features of the Dissected Till Plains have been formed by running water. The oldest of the Pleistocene glacial deposits are those of Nebraskan age, but are exposed only in the river valleys of southwestern Iowa and southeastern Nebraska. The upper parts of the hills are composed of glacial deposits which are younger and are known as Kansan deposits.

The western boundary of the Dissected Till Plains is obscure in many places. In northern Kansas the drift stops essentially at the western edge of Figure 1 which is the approximate location also of the edge of the Dakota sandstone escarpment or the Smoky Hills in Jefferson County, Nebraska and Washington County, Kansas. West of Lincoln, Nebraska the edge of the drift and of the Dissected Till Plains Province may be traced through several counties being approximately at the Big Blue River. The surface to the east has at least 200 feet relief cut into or through a thick, loess-mantled till sheet which presents an obscure morainal front to the west. On the west are the youthful Nebraska and Loess Plain Regions (Fig. 2). In northern Nebraska, the loess is uninterrupted in the Loess Hills and this is true as far south as the first tier of counties south of the Missouri River. The edge of the drift is at Verdigre Creek.

Bedrock Geology of the Area

Most of the bedrock formations of the Omaha area (Fig. 3) exert but little influence on the surface landforms. The bedrock formations exposed at the surface of the ground within the Omaha area are those of Pennsylvanian, Permian and Cretaceous Age.

RELIEF MAP OF NEBRASKA

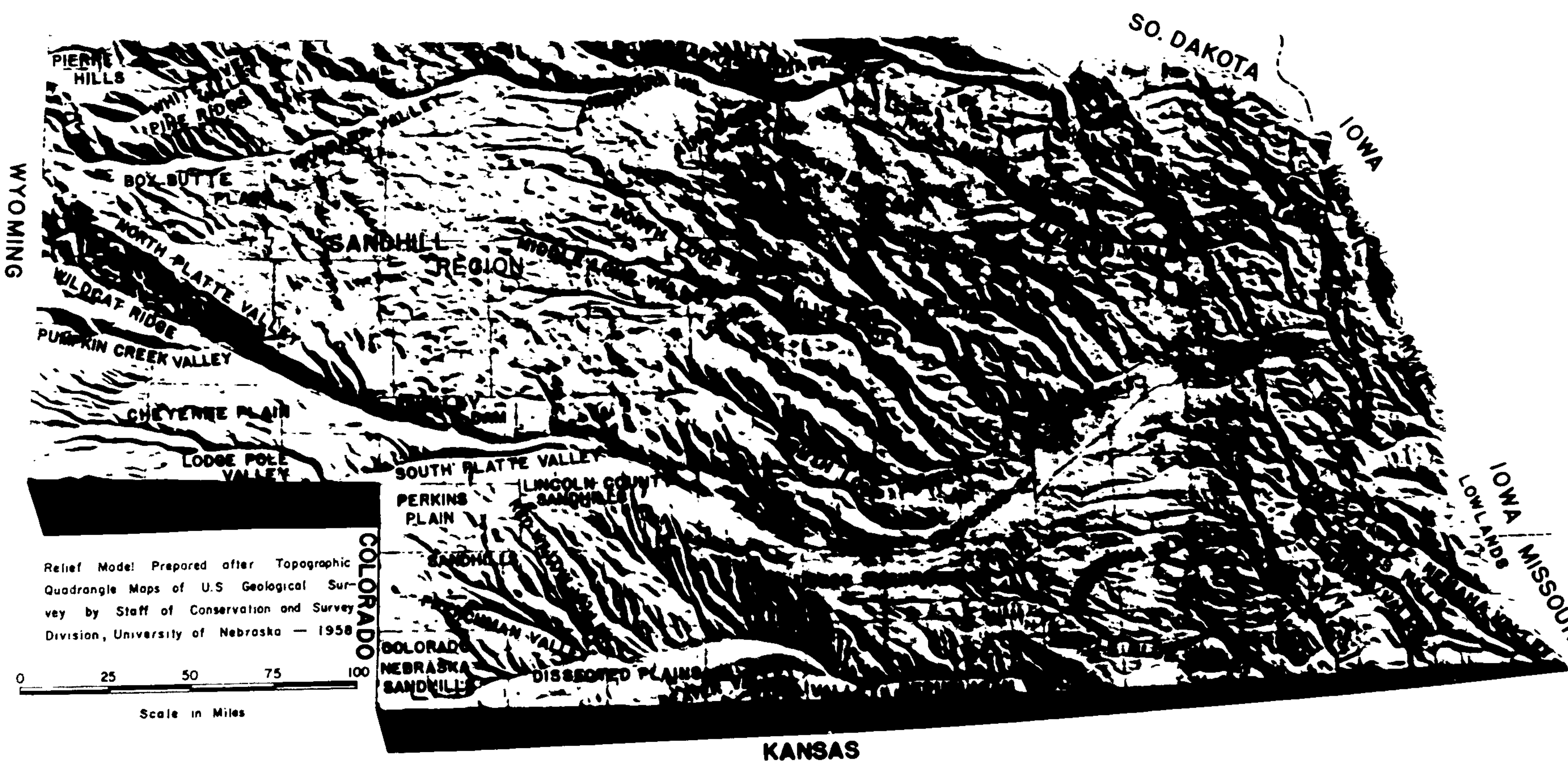

FIG.2. TOPOGRAPHIC REGIONS OF NEBRASKA
(MODIFIED FROM TOPOGRAPHIC REGIONS OF NEBRASKA OF G.E. CONDRA BY J.W. SKEHAN S.J.)

An inspection of Figure 5, an east-west geological cross section near the Kansas-Nebraska line will indicate the relationship between these three major groupings of strata.

Although only rocks of Pennsylvanian, Permian and Cretaceous age crop out within the restricted area of the Omaha region, nevertheless a thick series of strata of a much wider variety of ages is present in the subsurface. Knowledge of these is had from surface exposures in widely scattered portions of the Great Plains and Central Interior areas. It will be noted that in Pawnee and Johnson Counties (Fig. 3), the areas of most specific interest in this study, and more or less along the eastern border of these counties with Richardson and Nemaha Counties, there is a northerly trending exposure of rocks of Pennsylvanian age, the Virgil series (Table 1.2). These older strata are flanked on both the east and west by rocks of Permian Age, the Admire and Council Grove group strata with the Chase group exposed in the western portions of these counties.

It will be recognized from the distribution of these formations on the map in comparison with the cross section of Figure 5 that even at the surface of the ground the anticlinal or arch-like form of these strata is visible in the Table Rock Arch or, as it is sometimes referred to, the Nemaha Arch or Anticline. Table 1 presents a stratigraphic chart showing the detailed divisions into which the larger units of strata of various ages have been divided. Each of these sub-divisions is composed of a characteristic rock type and has fossil assemblages by which it is identifiable even in well cuttings. A more generalized stratigraphic chart of the strata of Iowa is presented in Table 4 which may serve as a basis for comparison of the section there with that represented in Nebraska.

Although the present study is focused mainly upon the basement complex, nevertheless a greater knowledge of the overlying strata

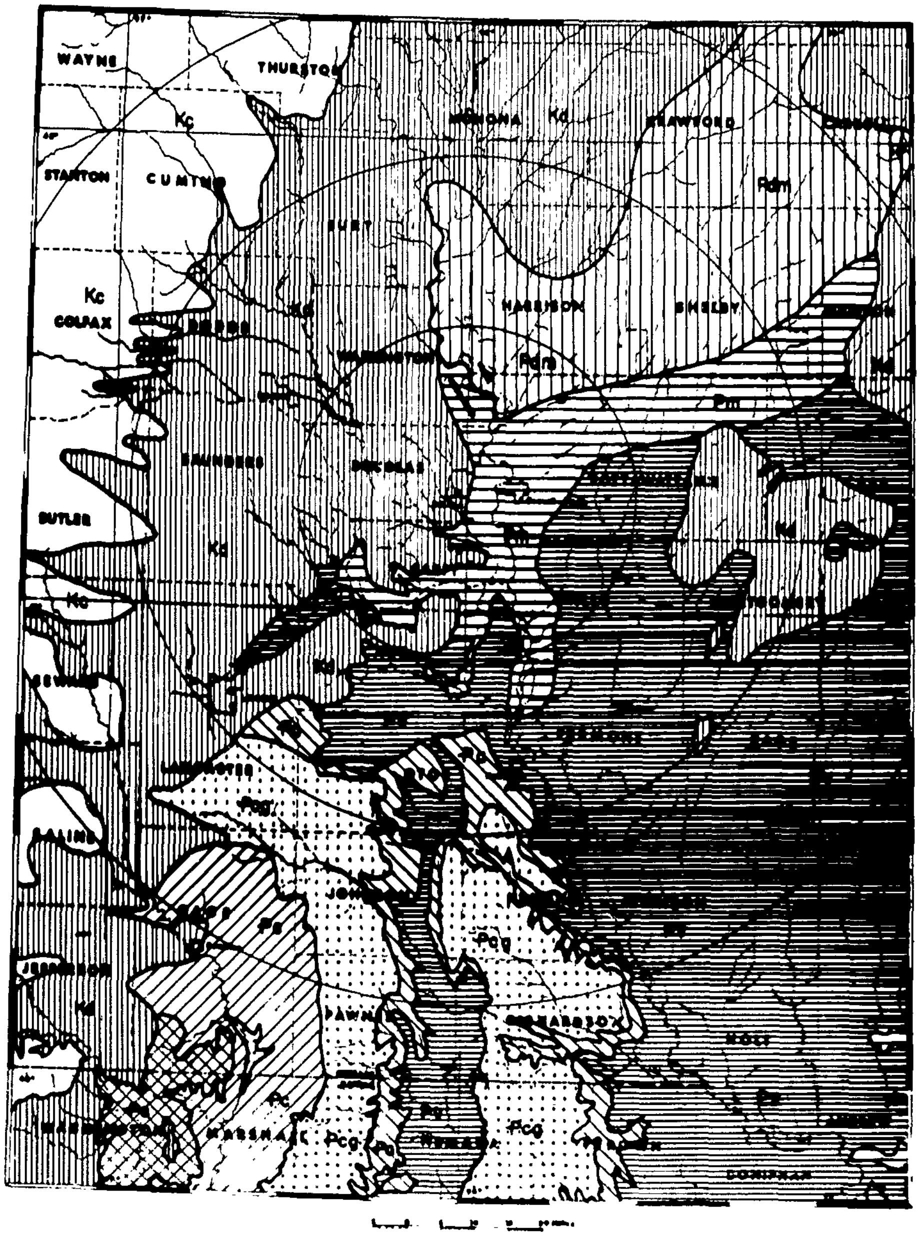

FIG. 3 GEOLOGIC MAP OF THE OMAHA AREA

CRETACEOUS
- Kc — COLORADO GROUP
- Kd — DAKOTA GROUP

PERMIAN
- Pw — WELLINGTON-SUMNER GROUPS
- Pc — CHASE GROUP
- Pcg — COUNCIL GROVE GROUP
- Pa — ADMIRE GROUP

PENNSYLVANIAN
- Pv — VIRGIL SERIES
- Pm — MISSOURI SERIES
- Pdm — DES MOINES SERIES

will yield a more penetrating understanding of this lowermost unit. For this reason and for the reason that the lowermost strata of Cambrian and Ordovician age have an intimate relationship to the basement complex, some attention will be given to rocks of these ages also.

Geology of the Strata Immediately Overlying the Basement Complex

An inspection of Figure 5 will make it clear that the rocks of Precambrian age have a rather complicated relationship to those of Cambrian, Cambro-Ordovician, Silurian, Devonian, Mississippian and Pennsylvanian ages. In the vicinity of 96° it is clear that the Humboldt Fault has downdropped the strata to the east along with the Precambrian sequence to a depth of some 2,600 feet or so. Along this fault the sediments of Cambrian through Pennsylvanian age are bounded on the west by Precambrian granite. Of special importance is the distribution and structural relationship of the St. Peter sandstone, a pervious water-bearing layer, found throughout a portion of the area at distances of a few inches to several hundred feet above the boundary of the Precambrian complex with younger rocks.

In an effort to delineate the topography of the Precambrian basement complex and to establish in more detail the influence of Precambrian topography upon the deposition of younger sediments the writer has compiled from numerous sources a map showing the top of the St. Peter sandstone, Figure 4. The St. Peter sandstone was chosen as a marker bed for several reasons. It has a lithology which at least near the boundary with the Precambrian is readily recognized. Since it is an aquifer many holes have penetrated it and it is a formation recognized by the drillers in contrast to certain others. In addition it is sufficiently close to the boundary of the Precambrian

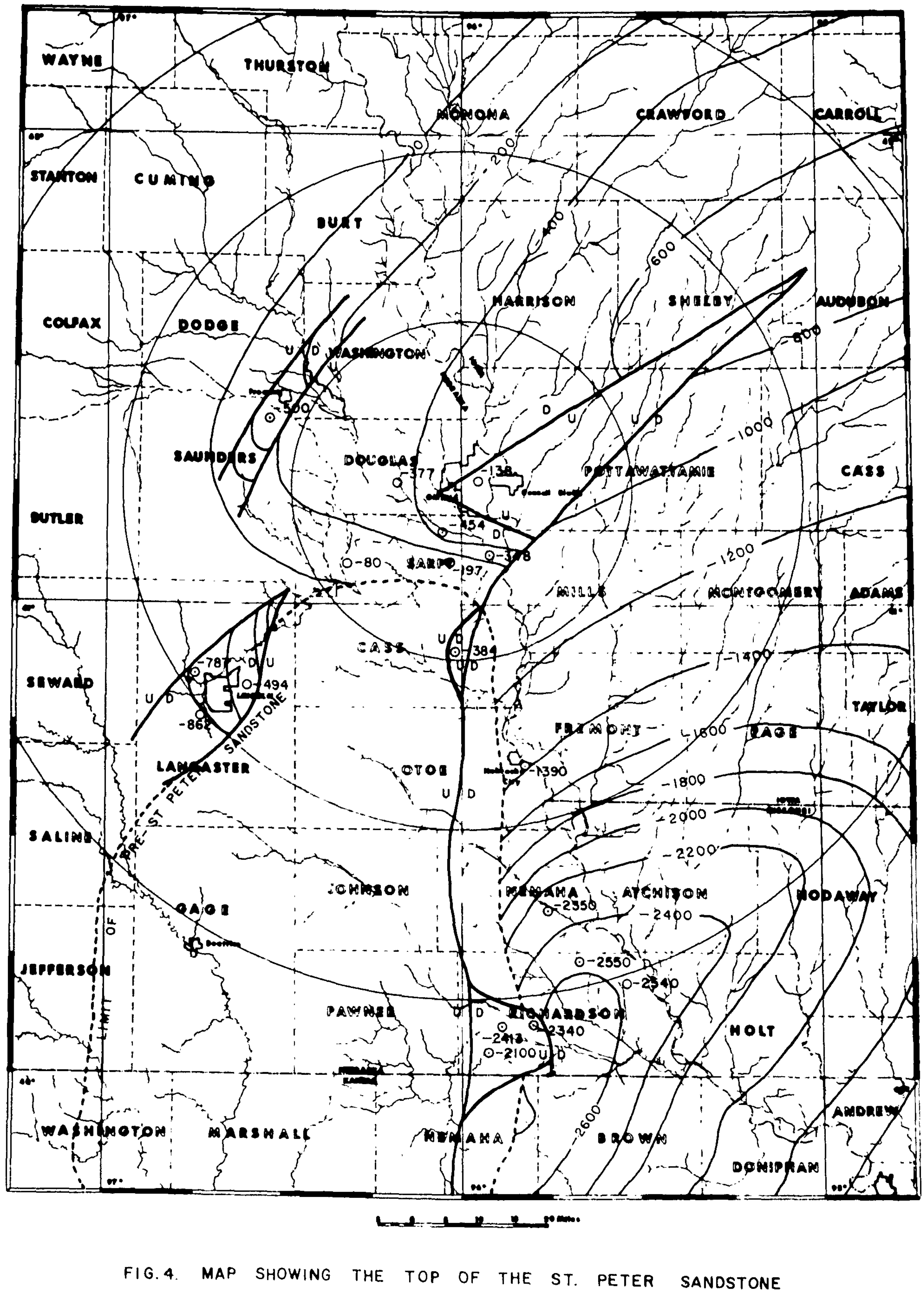

FIG. 4. MAP SHOWING THE TOP OF THE ST. PETER SANDSTONE

with the Reagan and other formations of Cambrian and Lower Ordovician age to be useful in delineating the desired structural features. It is moreover a petroleum reservoir in certain areas and is called by the petroleum drillers and geologists the "Wilcox Sand". (This should not be confused with the Wilcox Sand of the Gulf Coast and Atlantic Coastal area which has priority in the geological literature).

An inspection of Figure 4 will indicate that the St. Peter sandstone is absent throughout all or portions of the following counties: Richardson, Pawnee, Johnson, Nemaha, Otoe, Cass, Sarpy, Lancaster, Gage, Saline and Jefferson Counties. A dashed line indicates the limit of pre-St. Peter sandstone formation outcrop area if the formations younger than the St. Peter were stripped away.

This area (Figure 4) underlying the counties above enumerated plus Marshall and parts of Nemaha and Washington Counties, Kansas is underlain by rocks older than the St. Peter sandstone. This figure combined with Figure 5, the geologic cross section, will help to delineate the nature of the formation of the structures so presented. The data upon which the map is drawn is drill data and the location of holes furnishing data to the present study are shown in Figure 4. It is clear from Figures 4 and 5 that the Humboldt Fault zone persisted as a major structural feature until well after the time of deposition of St. Peter sandstone in the Ordovician. The presence of fault blocks on the down thrown side of the major fault is clearly indicated. Those fault blocks which are most reliably inferred from this compilation include that in Richardson County, Nebraska and Nemaha County, Kansas, and another in eastern Cass County; a third in Lancaster County; a fourth in Saunders, Dodge and Washington

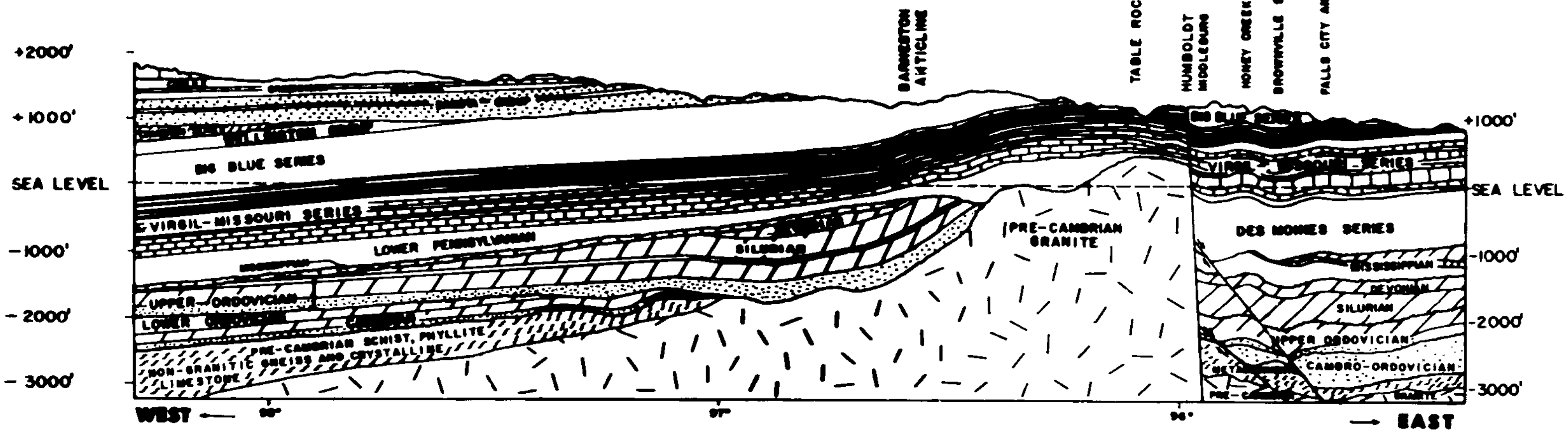

FIG. 5. EAST-WEST GEOLOGIC CROSS-SECTION NEAR KANSAS-NEBRASKA LINE

TAKEN FROM THE GEOLOGIC MAP OF NEBRASKA BY THE NEBRASKA GEOLOGICAL SURVEY, 1960
WITH MODIFICATIONS BY J. W. SKEHAN S. J. INCORPORATING DATA OF
MERRIAM AND HAMBLETON, 1956, p. 264. AND UNPUBLISHED DATA OF VIRGIL B. COLE, 1962.

HORIZONTAL SCALE

Table 1

GENERALIZED CORRELATION TABLE FOR NEBRASKA
SHOWING STRATIGRAPHIC POSITIONS OF
PRODUCING FORMATIONS

SYSTEM	SERIES	GROUP	FORMATION	MEMBER
QUATERNARY	RECENT			
	PLEISTOCENE			
TERTIARY	PLIOCENE		Ogallala	Kimball
				Sidney
				Ash Hollow
				Valentine
	MIOCENE	Hemingford	Sheep Creek	
			Marsland	
		Arikaree	Harrison	
			Monroe Creek	
			Gering	
	OLIGOCENE	White River	Brule	
			Chadron	
CRETACEOUS			Lance	
		Montana	Pierre	
			Niobrara	Smoky Hill
				Fort Hays
		Colorado	Carlile	Codell
				Blue Hill
				Fairport
			Greenhorn	
			Belle Fourche	
		Dakota (Kd)	Mowry	Gurley "D"
				Huntsman
				Cruise "J"
			Skull Creek	
			Fall River	
			Fuson	
			Lakota	
JURASSIC			Morrison	
			Sundance	
TRIASSIC	(Thin or Absent)			
	CIMARRON (Phosphoria-Cassa)	Kiger	(Freezeout-Glendo)	
		Salt Fork	Blaine (Minnekahta)	
			Flowerpot (Opeche)	
			Cedar Hills-Harper (Cassa)	

Table 1

GENERALIZED CORRELATION TABLE FOR NEBRASKA (Continued)

SYSTEM	SERIES	GROUP	FORMATION	MEMBER
PERMIAN	CIMARRON (Phosphoria-Cassa)		Stone Corral (Anhydrite)	
			Ninnescah	
	BIG BLUE (Broom Creek)		Wellington	
		Chase	Nolans	
			Odell	
			Winfield	
			Gage	
			Towanda	
			Holmesville	
			Barneston	
			Blue Springs	
			Kinney	
			Wymore	
			Wreford	
		Council Grove	Speiser	
			Funston	
			Blue Rapids	
			Crouse	
			Easley Creek	
			Bader	
			Stearns	
			Beattie (Cottonwood)	
			Eskridge	
			Grenola (Neva)	
			Roca	
			Red Eagle	
			Johnson	
			Foraker	
		Admire**	Jonesville	
			Falls City	
			Onaga (Indian Cave)	
	VIRGIL	Wabaunsee**	Richardson* (Brownville-Tarkio)	
			Nemaha* (Willard-Burlingame)	
			Sac-Fox* (Silver Lake-White) Cloud-Howard-Severy)	

Table 1

GENERALIZED CORRELATION TABLE FOR NEBRASKA (Continued)

SYSTEM	SERIES	GROUP	FORMATION	MEMBER
PENNSYLVANIAN	VIRGIL	Shawnee	Topeka	
			Calhoun	
			Deer Creek	
			Tecumseh	
			Lecompton	
		Douglas	Kanwaka	
			Oread	
	MISSOURI	Lansing	Stanton	
			Vilas	
			Plattsburg	
		Kansas City (Pkc)	Bonner Springs	
			Wyandotte (Argentine)	
			Lane	
			Iola	
			Chanute	
			Drum	
			Quivira	
			Westerville	
			Cherryvale	
			Dennis (Winterset)	
			Galesburg	
			Swope (Bethany Falls)	
			Ladore	
			Hertha	
		Pleasanton		
	DES MOINES	Marmaton		
		Cherokee		
MISSISSIPPIAN	IOWA	Meramec	St. Louis	
			Spergen	
			Warsaw	
		Osage	Keokuk	
			Burlington	
		Kinderhook	Chouteau	
			Chattanooga	
DEVONIAN (D) (Hunton)	SENECAN		Cedar Valley	
			Independence	
			Wapsipinicon	

Table 1

GENERALIZED CORRELATION TABLE FOR NEBRASKA (Continued)

SYSTEM	SERIES	GROUP	FORMATION	MEMBER
SILURIAN (Lower Hunton)	NIAGARAN			
ORDOVICIAN			Maquoketa (Sylvan) Galena (Viola) (Ov) Decorah (Simpson) Platteville (Simpson) St. Peter (Wilcox) (Osp)	
			Oneota (Upper Arbuckle) Gunter (Upper Arbuckle)	
CAMBRIAN			Bonneterre (Lower Arbuckle) La Motte (Reagan)	
PRECAMBRIAN			Igneous & Metamorphic Rocks	

*Subgroups

**Reclassification of Lower Permian and Upper Pennsylvanian as adopted by several midcontinent State Geological Surveys and U. S. Geological Survey, 1955.

Note: The oil field or essentially equivalent formation name is shown in parenthesis. The letter symbol indicates the producing formations.

Taken from: Reed, E. C. and Svoboda, R. F. (1957) Nebraska Deep Well Records: Nebraska Geological Survey Bulletin 17, The University of Nebraska, Conservation and Survey Division, Lincoln, Neb., pp. 8-9.

Counties and the fifth in Douglas County, Nebraska and Pottawattamie and Mills Counties, Iowa and possibly extending into Shelby and Audubon Counties, Iowa. It is clear that the Richardson and Cass County blocks occur at different locations from the position of the Precambrian fault blocks shown on Plate 1 (in pocket) where these are shown as occurring in Nemaha County, Kansas and on the boundary of Pawnee and Richardson Counties, Nebraska. On Plate 1 the Pawnee and Richardson Precambrian fault block seems to be developed on the west side of the main fault whereas the data from Ordovician rocks seems to indicate that the fault zone is much more extensive in this area than has hitherto been generally suspected. In any case it is clear that the Nemaha Arch region has been a zone of crustal adjustment over prolonged periods of time. The fact that Table Rock Arch or the Nemaha Arch, as it is commonly referred to, shows deformation of rocks of Permian age indicates that conspicuous deformation was going on over a period of at least four hundred million years from the end of Precambrian time to the end of Paleozoic time. There are further suggestions which will be treated later to indicate that this region is still being affected by at least recognizable amounts of crustal unrest (Figure 8). Further data on drill holes from the Ordovician St. Peter sandstone and a more concentrated study of drill holes, particularly those unpublished, would add considerably to our knowledge of features such as the five fault blocks outlined above. Similar study on other conspicuous marker horizons would almost certainly indicate repeated movements on older faults and would certainly reveal new fault blocks hitherto unsuspected by all except geologists who have available to them a great deal of unpublished drilled data. An examination of Table 4, second page and a comparison of these formations with those of Table 1.4 and

Table 2

Published data on Precambrian Rocks in Southeastern Nebraska

	County	Company, Well number and Farm	Location	Surface Elev. ft.	Depth to PC ft.	Elev. of PC ft.	PC Rock Type	Back Unit on Basement	Total Depth ft.
N1	Sarpy County	Victor Jeep Well Victor 1 Jeep Assoc., Hans Rahn Farm	NW 1/4 SE 1/4, Sec 23, T. 14 N., R. 12 E.	1114'	1870'	-756'	Sioux Quartzite 39'	C or PC Red Clastics Ser. Arkosic ss or cgl., 20'	1909'
#1	Reed, E. C. (1938) Correlation of Formations Drilled in Midland Forster Well near Fremont, Nebr.: Nebr. Geol. Surv., Paper No. 13, p. 16.								
#2	Reference on Victor Jeep: Contra, G. E., Schramm, E. F., Lugn, A. L., (1931) Deep Wells of Nebr.: Nebr. Geol. Surv., Bull. 4, 2nd ser., pp. 64-68.								
N2	Saunders County	Midland Oil Co. Midland Forster Well #1A	SE 1/4, NE 1/4, Sec. 5, T. 16 N., R. 8 E.	1373'	2187'	-814'	C or PC ss, medium grained. angular, reddish with reddish silty clay cementing material and glauconite	Jordan ss, med. to coarse grain, friable, 15'	
	Reference #1 of N1		p. 20						
N3	Cass County	Amerada Petroleum Co. 4 mi N. & 2 mi W. of Nehawka	NE of Sec 26 T. 11 N., R. 12 E.	1134'	1567'	-233'	Sioux quartz. Mostly reddish to grayish brown. fresh arkose quartz. with some altered chorite and diabase cemented more or less with calcium carbonate, 261'.	ss and cgl. with dark pebbles and fragments of Oboloia Brachiopods of St. Peter ss 49'.	1828'
	Best sub-surface record of Nebr.								
	Reference #2 of N1		pp. 71-86						

Table 2

Published data on Precambrian Rocks in Southeastern Nebraska (Continued)

	County	Company, Well number and Farm	Location	Surface Elev. ft.	Depth to P€ ft.	Elev. of P€ ft.	P€ Rock Type	Back Unit on Basement	Total Depth ft.
N4	Pawnee County	DuBois Well (Bern Well Kan) Rock Island R.R. Co.	Center Sec. 25, T. 1 N., R. 12 E.	1019'	558'	+461'	Granite pink due feldspar, 7'	ss of Des Moines Series, 75'6"	565'
	Reference #2 of N1		pp. 129-131						
N5	Pawnee County	Table Rock #1 Cuhn & Hurst Drilling Co., Vertiska Farm 2 mi N of Table Rock	NE ¼ Sec. 29, T. 3 N., R. 12 E.	1030'	700'	+330'	Granite	Undetermine thickness of metamorphosed shs. and lss.	1500'
	Reference #2 of N1		p. 131						
N6	Pawnee	N.F. Clark Co. Table Rock #2	NW Sec. 12 T. 2 N. R. 11 E.	1114'	750'	+364'	Granite 15'	Unknown	765'
	Reference #2 of N1		p. 132						
N7	Lancaster County	State Board of Pub. Lands & Buildings, Capital Beach Well	South of Capital Beach, W of Lincoln in Sec. 20, T. 10 N., R. 6 E.	1140'	2193'	-1053'	Heavy, red rock, partially metamorphosed, in many approaching quartzite. Destitute of fossils. Sioux quartzite (?), 270'	Soft red ss friable coarse, argillaceous in places, 71' 7", Ordovician Shakipee Dolomite (?) 113' 2".	2463'
	Reference #2 of N1		pp. 138-160						

Table 2

Published data on Precambrian Rocks in Southeastern Nebraska (Continued)

	County	Company, Well number and Farm	Location	Surface Elev. ft.	Depth to P€ ft.	Elev. of P€ ft.	P€ Rock Type	Back Unit on Basement	Total Depth ft.
N8	Otoe County	Nebr. City Brick Plant Well	SW 1/4 Sec. 10, T. 8 N., R. 14 E.	932'	2869'(?)	-1942	Quartzite	Eau Claire marl or -- red clastics.	2874'
	Reference #2 of N1		pp. 90-108.						
N9	Woodbury County	Sioux City Water Works (Magee) Well		1125'	1235'	-786'	Precambrian		2011'

Table 2

Published data on Precambrian Rocks in Kansas

	County	Company, Well number and Farm	Location	Surface Elev. ft.	Depth to PC ft	Elev. of PC ft.	PC Rock Type	Back Unit on Basement	Total Depth ft.
K1	Nemaha County	Kaufman & Heim No. 1 Smith	22-1-11E	1250?	719	+531?	104' granite wash on granite	Penn.	913'
	Cole, V. B. & Merriam D.F. (1962) Progress Report of the Kansas Basement Rocks Committee and Additional Precambrian Wells: State Geological Surv. of Kan., Bull. 157, pt. 2, p. 10.								
K2	Marshall County	Five Nations No. 1 See-master	24-3-8E C NW NW	1240'	1470'	-230	clastics	Simpson	1627'
	Marshall County	Five Nations No. 1 Sandman	8-3-9E C SE SE	1280'	1391'	-111'	granite	Simpson	1478'
	Reference #1 of K1		p. 11						
K3	Decatur County		NE cor. Decatur Co. in SW., NE. NE., Sec. 25, T. 2 S., R. 26 W.	2591'	3930'	-1339'	Granite pink, very feldspathic, 56'		3986'
	Reference #2 of N1		pp. 224-227.						

Figure 5, will make it clear that the interval between the Precambrian Sioux quartzite and the St. Peter sandstone has variable thicknesses of strata in different places. This in itself is an indication of the uneven topography and variable structure that characterized the Precambrian basement complex during Ordovician time. It will also serve as a basis for comparison of the geologic section of Iowa with that of Nebraska.

Precambrian Basement Complex of the Omaha Area

The depth to the Precambrian basement complex, the topographical expression of the Precambrian surface and the nature of the rocks of which it is composed is a complex problem. The present investigation has been focused upon this problem and a certain amount of data of varying reliability has been obtained.

Published data on Precambrian rocks in Southeastern Nebraska is difficult to find but what is available is presented in Table 2. Data from adjacent parts of northeastern Kansas is also included. Much drill data relating to the basement complex is contained in the files of various petroleum companies and when such data becomes available our knowledge of the depth to, configuration, and rock composition of the basement complex will be greatly enhanced. Table 3 comprises a series of data compiled by Edward G. Lidiak and is incorporated here in full. This relates exclusively to an area of special interest, mainly Johnson and Pawnee Counties. This Table represents data from new wells in these counties. The most reliable and complete data available to the writer on the bedrock elevation and topography of the basement complex is that compiled on Plate 1. This map is mainly an unpublished map compiled by Virgil B. Cole in 1962. The Kansas portion of the map has been published as the Basement Contour Map (1962). Carlson's

Table 3

New Basement Wells in Pawnee and Johnson Counties, Nebraska
Data supplied and identifications made by
Edward G. Lidiak, Balcones Research Center,
The University of Texas, Austin 12, Texas
November 21, 1962

Owner and Well Name	Location	El. of basement	Depth to basement	Basement sample interval	Rock type
Pawnee County					
1. B. E. Thorne Rohlmier No. 1	13-1N-12E C SE SE	+493 ft.	502 ft.	502-539½ ft.	med. gr. lineated biotite granite with biotite-rich schlieren (core sample).
2. Pieper *et al*, Pesek No. 1	13-1N-12E SW SW SE	+493 ft.	512 ft.	512-585 ft.	med. gr. foliated biotite granite with some biotite-rich intervals.
3. Herbert Droge *et al* Small No. 1	34-2N-10E	+482 ft.	871 ft.	871-880 ft.	coarse grained granoblastic quartz and potassium feldspar rich granitic rock (not enough material to identify rock type with

New Basement Wells in Pawnee and Johnson Counties, Nebraska (Continued)

Owner and Well Name	Location	El. of basement	Depth to basement	Basement sample interval	Rock type
					certainty--probably a metamorphic).
4. W. M. Edwards Hunzeker No. 1A	26-2N-12E	not known	730 ft.	730-745 ft.	coarse grained granoblastic quartz and potassium feldspar-rich granitic rock (very similar to the Herbert Droge - Small No. 1 well).
5. Black Gold Oper. Bernadt No. 1	31-3N-11E	+533 ft.	665 ft.	665-730 ft.	med-coarse gr. foliated biotite granite
6. Earl A. Emal Blecha No. 1	15-2N-12E	+483 ft.	610 ft.	610-652 ft.	coarse grained biotite granite gneiss

New Basement Wells in Pawnee and Johnson Counties, Nebraska (Continued)

Owner and Well Name	Location	El. of basement	Depth to basement	Basement sample interval	Rock type
Johnson County					
7. Stanolind Stratigraphic No. 6	4-4N-12E	+506 ft.	760 ft.	760-808 ft.	med-coarse grained granoblastic quartz and potassium feldspar-rich granitic rock.
8. Stanolind Stratigraphic No. 7	20-5N-12E	+395 ft.	845 ft.	845-859 ft.	med. grained biotite granite.
9. Gear *et al* Ekke Paben No. 1	19-5N-9E	+66 ft.	1410 ft.	1410-1632 ft.	med. grained biotite granite gneiss.
10. Stanolind Stratigraphic No. 4	6-6N-12E	-116 ft.	1140 ft.	1140-45 ft.	med. grained biotite granite.
11. Stanolind Stratigraphic No. 8	8-5N-12E	+273 ft.	978 ft.	978-980 ft.	med. grained granoblastic quartz and potassium feldspar-rich granitic rock.

New Basement Wells in Pawnee and Johnson Counties, Nebraska (Continued)

Owner and Well Name	Location	El. of basement	Depth to basement	Basement sample interval	Rock type
12. Stanolind Stratigraphic No. 9	16-5N-12E	+369 ft.	875 ft.	875-882½ ft.	med. grained granoblastic quartz and potassium feldspar-rich granitic rock.

shows only one topographic high in Pawnee and Johnson Counties. Cole's compilation (Plate 1) indicates two bedrock topographic highs, one in west-central Pawnee and Marshall Counties, Nebraska and Kansas respectively, trending in an northeasterly direction. A second topographic high is located on the Johnson-Nemaha County boundary, Nebraska and easternmost Pawnee County, Nebraska and in Nemaha County, Kansas. This topographic high trends almost north-south and its trend is probably controlled by the Humboldt Fault zone.

Recent unpublished drill data compiled on wells, the cores and cuttings of which have been examined in a preliminary way by Edward G. Lidiak, have been made available for the present study. The data presented by him has been set forth in Table 3 and has been incorporated into Plate 1 of this report. These data have made necessary only minor changes in Cole's original map.

The Forest City Basin occupies the area east of the Humboldt Fault and forms a most prominent downdropped block. The dip slip component or the amount of movement essentially in the vertical plane is approximately 2,600 feet. Figure 5 shows a cross section essentially along the Kansas-Nebraska boundary indicating this amount of displacement down the dip of the fault. The trend of the maximum depression is more or less parallel to the Humboldt Fault itself (Plate 1). At least four fault blocks have been recognized along the Humboldt Fault zone, one in Nemaha County (Pl. 1), another in westernmost Richardson County (Pl. 1 and Fig. 4), a third in western Nemaha County, Nebraska and a fourth in Cass County (Fig. 4). A fifth is probably present in Douglas, Sarpy and Pottawattamie Counties.

The deepest part of the Forest City Basin is in the vicinity of

the Nemaha-Richardson County boundary with an elevation, estimated on the basis of drill data, of -3,010 feet. Several values approximating this depth have been found in the vicinity of the Missouri River in these two counties and in adjacent portions of Missouri. A ridge of basement complex rocks separates the above depression from a comparable low in Brown County. This ridge, located on the 40° parallel, has values on two drill holes of approximately -2,600 feet to 2,800 feet and in Brown County values of approximately -2,800 feet to 2,900 feet have been estimated on the basis of drill holes to horizons lying above the basement complex. The shallowest depth in the Forest City Basin east of the Humboldt Fault is -1,500 feet in Otoe County. Depths increase along the fault to -2,100 feet to 2,200 feet in Richardson County and deepen to a little more than 2,600 feet in Nemaha County, Kansas. Along the Humboldt Fault in Nemaha County, Kansas the above mentioned fault block rises to the shallowest depth east of the fault at -1,154 feet. The highest elevation west of the fault is at elevation +539 feet in southeastern Pawnee County; at +485 feet in northeastern Pawnee County; and +521 feet in central Pawnee County, Nebraska.

The topography drops off more gradually west of the Nemaha Arch to depths to -2,000 feet in southwesternmost Washington County; to -1,800 feet in Jefferson-Washington County along the Nebraska-Kansas boundary; and to -1,400 feet in Saline County. The greatest depth immediately west of the Humboldt Fault is -897 feet measured on what is interpreted by the writer to be a fault slice lying in the fault zone and east of the north-south trending Nemaha Arch.

The fact that the trends adjacent to the Humboldt Fault are essentially north-south and that some 10 to 30 miles west of this are northeasterly, suggests to the writer that the northeasterly trending valleys

Table 4

GENERAL SECTION OF IOWA STRATA

Group	System	Series	Formation	Character
CENOZOIC	Recent			Soil,
	Quaternary, patches of Tertiary	Pleistocene	Wisconsin	Boulder clay
			Peorian	Loess, forest bed, sand, gravel
			Iowan	Boulder clay
			Sangamon	Gumbotil, soils, forest beds, sand, gravel
			Illinoian	Boulder clay
			Yarmouth	Gumbotil, peat, soil, sand, gravel
			Kansan	Boulder clay, gravel
			Aftonian	Gumbotil, peat, soil, gravel
			Nebraskan	Boulder clay, gravel
MESOZOIC	Cretaceous	Upper Cretaceous	Colorado	Shale, limestone
			Dakota	Sandstone
PALEOZOIC	Permian	Fort Dodge		Gypsum, shale
	Pennsylvanian	Missouri	Wabaunsee	
			Shawnee	
			Douglas	Limestones, shales, coal
			Lansing	
			Kansas City	
		Des Moines	Pleasanton	Shales, coals, sandstones, limestones
			Henrietta	
			Cherokee	
	Mississippian	Iowa Series: Meramec	Ste. Genevieve (Pella)	Limestones, marls, sandstones
			St. Louis	
			Spergen	
			Warsaw	
		Iowa Series: Osage	Keokuk	Limestones
			Burlington	
		Iowa Series: Kinderhook		Shale, limestones
	Devonian	Upper Devonian	Lime Creek-State Quarry	Shale, limestones
			Cedar Valley	Limestone, shale
			Wapsipinicon: Davenport	Limestone
			Wapsipinicon: Independence	Shale
			Wapsipinicon: Otis	Limestone

Table 4

GENERAL SECTION OF IOWA STRATA (Continued)

Group	System	Series	Formation	Character
PALEOZOIC	Silurian	Cayugan?	Salina? (nowhere exposed)	Limestone, gypsum
		Niagaran	Gower Hopkinton	Dolomites
		Alexandrian	Waucoma	Limestone
	Ordovician	Cincinnatian	Maquoketa	Shale, dolomite
			Galena	Dolomite
		Mohawkian	Decorah	Shale, limestone
			Platteville	Limestone, shale
			Glenwood	Shale
			St. Peter	Sandstone
				Dolomite
		Canadian	Prairie du Chien {Shakopee New Richmond Oneota}	 Sandstone Dolomite
	Cambrian	Croixan	Jordan	Sandstone
			St. Lawrence {Trempealeau	Dolomite, marls
			Franconia}	Shale, glauconite, marl
			Dresbach } Not exposed in Iowa	Sandstone
			Eau Claire } Not exposed in Iowa	Shale, sandstone
			Mt. Simon } Not exposed in Iowa	Sandstone, shale
			Red clastic beds (unnamed) } Not exposed in Iowa	Sandstone, shale conglomerate
PROTERO-ZOIC	Algonkian	Huronian	Sioux	Quartzite
ARCHEO-ZOIC	Laurentian?		Nowhere exposed	Granite, schist

From Iowa Geological Survey Annual Report, Vol. XXXIII, 1927, pp. 23-24.

in the Precambrian complex through Marshall and Pawnee Counties and the one in northwestern Marshall County trending through southeasternmost Gage and Johnson Counties should be investigated for the presence of important faults subsidiary to the Humboldt Fault.

Hershey and others (1960) have reported on the Thurman-Redfield structural zone which trends north-east south-west through Montgomery, Adams and Cass Counties, Iowa (Figure 1). In the past this structural zone has been interpreted as a major fault zone but the Iowa Geological Survey at present is not convinced that the "Thurman-Wilson Fault", so referred to in the older literature, is a true fault and prefers to designate the feature as a structural zone (Hase, D. H., written communication Oct. 5, 1962). Magnetic data suggest that this zone may represent a contact between more basic rocks to the west and more acidic rocks to the east, or may represent a change in basement complex elevation higher to the west than on the east. Deep refraction seismic studies made along the Mid-Continent Gravity High completed in the fall of 1962 may shed more light upon the structures of this part of the Omaha area but the preliminary results are not available at this time.

A comparison of the contour map of the Precambrian basement complex by Carlson (1961) and that by Cole (1962) indicates that these do not match along the Kansas-Nebraska boundary. Carlson's map of Nebraska and the compilation by Cole presented in Plate 1 differ somewhat and in particular in the vicinity of Johnson and Gage Counties. Another factor which may be responsible for variations between the two maps along these state boundaries is that there is an absence of data along the Gage and Pawnee County boundaries. Cole's map extends structural trends into Nebraska on line with those observed in Kansas whereas Carlson's does not incorporate such interpretative trends. An additional factor which may account

Table 5

PRECAMBRIAN BASEMENT WELLS OF IOWA

(Data in files of Io a Geological Survey)

County	Well Name	Location	Elev.	T/Base.	Total	Base. Lith.
Allamakee	Lansing city well 4	29-99N-3W	642	712	721	Granite
Boone	Ogden city water well 2	36-84N-28W	1095	2830	2852	Red Clastics
Cerro Gordo	Mason City 8	3-96N-20W	1098	1698	1765	Granite
Cerro Gordo	Mason City 12	16-96N-20W	1164	1667	1577	Granite
Dubuque	Dubuque city well 8	7-89N-3E	610	1765	1775	Granite
Dubuque	Farley + Loetscher Co.	24-89-2E	608	2005	2010	Granite
Dubuque	Dubuque city well #5	7-89N-3E	626	1800	1811	Granite
Fremont	Ohio Oil Co. 1 Wisnom	23-68N-41W	937	3160	3375	Red Clastics?
Ida	Holstein town well 2	35-89N-40W	1452	2013	2040	Granite
Kossuth	Algona city well 3	2-95N-29W	1212	1838	1885	Granite
Lyon	Dr. I.P. Tiezan 1 H. Gisolf	16-100N-45W	1367	393	443	Sioux Quartzite
Osceola	Sibley town well (1946)	13-99N-42W	1514	749	757	Metamorphic Rock?
Page	Iowa First Dev.Co. 1 Wilson	25-68N-37W	977	?	5305	Red Clastics
Plymouth	LeMars town well 1	16-92N-45W	1275	1060	1560	Metamorphic Rock?

Table 5

PRECAMBRIAN BASEMENT WELLS OF IOWA (Continued)

County	Well Name	Location	Elev.	T/Base.	Total	Base. Lith.
Sioux	Hull Town 2	26-97N-45W	1427	760	768	Quartz Porphyry
Woodbury	Sioux City Waterworks 1 Magee	29-89N-47W	1125	1260	2011	Gneiss or Schist?
Webster	Ft. Dodge city no. 15	19-89N-28W	980	2290	2310	Serpentinized basalt
Story	Nevada city no. 3	6-83N-22W	990	3110	3342	Red Clastics
Marshall	State Center Town	10-83N-20W	1066	3125	3310	Red Clastics

for some difference in interpretation involves the problem of what constitutes the top of the Precambrian basement complex. In some cases there is a veneer of so-called "granite wash" which in composition is essentially granite and represents either a deeply weathered portion of the granite weathered in place and not transported or it may consist of material derived from the Precambrian granite and transported some distance.

Table 5 represents available data in the files of the Iowa Geological Survey and is presented for inspection in this report through the courtesy of the Survey. All of these data relating to the composition of rock types in the basement complex have been incorporated into Plate 2 where the distribution of Precambrian rock types of the Great Plains and Central Interior and related areas has been presented.

Table 6 incorporates published data on Precambrian wells mainly in the central Great Plains but includes data also from parts of other physiographic provinces. Incorporated into this list are those not only from various parts of Nebraska and Kansas but also those from South Dakota, a few from Oklahoma, Missouri and Iowa. In the first four columns of this chart are presented data sufficient to locate the well and in the last four columns the elevation above sea level, the depth from the surface of the ground to the bottom of the well, and the depth from the collar of the well to the top of the Precambrian complex is given. In the final column the type of rock encountered is presented. On the basis of a fairly widespread network of boring data it is clear that the central part of the Nemaha Arch consists of Precambrian granite and granite gneiss. For all practical purposes this may be considered to be a more or less ordinary granite which however has been subjected to repeated stressing, fracturing and faulting. The Humboldt Fault has been a persistent fault throughout much of geologic time and certainly during the past 600 million

Table 6

Published Data on Precambrian Wells in the Central Great Plains

NEBRASKA

Town	County	Sec. T. R.	Name	Ele-vation	Depth of Well	Depth to Precam-brian	Rock
Bassett	Rock	10-30N.-19W.	Bassett Oil and Gas Co.		2965	2940	Hornblendite, Hornblende-schist
Cambridge	Furnas	13-5N.,26W.	Watkins	2360	3423	3360	Granite
Chadron	Dawes	33-35N,-47W.	Duthie	3025	2947	2870	Precambrian
DuBois	Pawnee	25-1N.-12E.	Church	1019	565	558	Granite
Lincoln	Lancaster	20-9N.-7E.	Capitol Beach	1150?	2463	2193	Sioux quartzite
Lincoln	Lancaster	4-9N.-6E.	Burnham	1140?		?	Sioux quartzite
Nehawka	Cass	26-11N.12E.	Nehawka, Amerada		1828	1567	Sioux quartzite
Papillion	Sarpy	23-14N.-12E.	Jeep	1114	1909		Sioux quartzite
Table Rock	Pawnee	29-3N.-12E.	Hurst	1030	1500?	585	Granite
Table Rock	Pawnee	12-2N.-11E.	N. F. Clark		765	750	Granite

KANSAS

Town	County	Sec. T. R.	Name	Ele-vation	Depth of Well	Depth to Precam-brian	Rock
Alta Vista	Wabaunsee	?-13-8			2000		Granite
Anson	Sumner	36-31-2	Sleige Theta-Schaffer Co.	1190	3565	3420	Granite
Beattie	Marshall	29-2-9E.	C. A. Harry	1190	3000	1420	Granite
Beattie	Marshall	20-2-9E.	Blue-Vermillion	1189	1271	1268	Granite
Burns	Marion	14-23-5	Lilly	1480	2500	2331	Granite
Burns	Marion	26-23-5	Covey Roxana Co.	1450	2609	2545	Granite
Burns	Marion	7-22-4	Milne Watchorn	1460	2525	2326	Granite
Blue Rapids	Marshall	?-4N.-7			1600?	1550?	Granite
Columbus	Cherokee	24-33-23	City of Columbus	1261	1793	1785	Granite
Cedar Point	Chase	25-20-5	McLinden, Prairie Oil & Gas	1329	3050	3040	Granite
Elk	Chase	34-19-7	Poor Farm, Empire Co.	1203	2525	1805	Granite
Elmdale	Chase	7-19-6	Markey		2585		Granite
Elmdale	Chase	2-20-7	Kaufman	1388	3055	1890	Granite
Elmdale?	Chase		Empire		3067	1870	Granite
El Dorado	Butler	12-26-4	Denny, Union Oil	1370	2929	2805	Granite

Published Data on Precambrian Wells in the Central Great Plains (Continued)

KANSAS (Continued)

Town	County	Sec. T. R.	Name	Elevation	Depth of Well	Depth to Precambrian	Rock
El Dorado	Butler	11-26-4	Shumway Gypsy Co.	1400	2715	2675	Granite
El Dorado	Butler	17-28-4	Varner. Empire Co.	1253	3124	2800	Granite
El Dorado?	Butler	20-30-16	Empire?			2285	Granite
Gorham	Russell	32-13-15	Baxter, Keyes Bros.		3328	3298	Granite
Gorham	Russell	?-13-15	Keyes Bros.		3329	3298	Granite
Hymer	Morris	34-17-7	Moffett ?, Empire Co.	1560	2608	2506	Granite
Hymer	Chase	5-18-6	Southwarth National and Marland	1515	2523	2513	Granite
Hymer	Chase	15-18-6	Whitney	1400	2441	2427	Granite
Hymer	Chase	4-18-7	Anderson	1400	2625	2110	Granite
Kelso	Morris	24-15-7	Whiting, Cosden Co.	1384	2551	2512	Granite
Kelso	Morris	11-16-7	Hiegle	1450	2150	1900	Granite
Kelso	Morris	?-15-8			2552	2513	Granite
Norcatur	Decatur	25-2-26	Marland Oil Co.	2591	3986	3920	Granite
Neodesha	Wilson	?-30-16			2285		Granite
Onaga	Pottawattomie	34-6-11	Rokes Empire Co.	1200	1810	960	Granite
Onaga?	Pottawattomie	?-6-11			1725	1035	Granite
Paola	Miami	16-17-23			2500	2260	Granite
Peabody	Marion	?-21-3?		1355	3616	3395	Schist
Randolph	Riley	?- 7-6			2630		Granite
Seneca	Nemaha	34- 2-12		1150	746	586 or 620	Granite
Wabaunsee	Wabaunsee	1-11-9	Root	1069	1990	1180	Granite
Winkler	Riley	2- 7-5	Droll, Gypsy Co.		2520	2385	Granite
Wamego	Wabaunsee	12-10-10	Miller		2400	2300	Granite
Yates Center	Woodson	17-25-15	Stoker Co.	1125	2591	2555	Granite
Zeandale	Riley	28-10-9	Bardwell	1050	1020	928	Granite
Zeandale	Riley	26-10-9	Bardwell	1075	1093	958	Granite

Published Data on Precambrian Wells in the Central Great Plains (Continued)

SOUTH DAKOTA

Town	County	Sec. T. R.	Name	Elevation	Depth of Well	Depth to Precambrian	Rock
Aberdeen	Brown	123-64			1221-1267	1221	Quartzite Rock
					1267-1300		
Albee	Grant	118- 48			168	168	Granite
Alexandria	Hanson	102- 58			496	40	Quartzite
						490	With sandstone and water below, and in one well hard rock.
Alcester	Union	95- 49			480		Hard Rock
Avon	Bonhomme	94- 61-22	Layson Well		1075 1/2	1074	Very hard rock
Beulah	Douglas	26-100-64	County		937	937	Hard rock "Granite"
Brookings	Brookings	110- 49			556		Quartzite
Crandon	Spink	18-114-62	Building		922-995	922	Quartzite
					995-998 1/2		Granite
Canastota	McCook	101- 53			140		Quartzite
Epiphany	Hanson	13-104-57			204	204	Hard rock
Epiphany	Hanson	N.E. 1/4 17-104-57			510	510	Gray granite
Epiphany	Hanson	N.W.1/4 19-104-57			557	557	Gray granite
Ethan	Davison	101- 60			320	320	Hard rock
Elm Spring	Meade	4- 13			412	247	Quartzite
Elk Point	Union	91- 49			303	303	Hard rock
Elk Point	Union	91- 49			367	367	Hard rock
Fulton	Hanson	24-104-58			518	512	Granite
Fulton	Hanson	S.W.1/4 25-104-58			506	506	Diabase
Fulton	Hanson	36-104-58			480	480	Quartzite
Fulton	Hanson	103- 58			30	30	Quartzite
Farmer	Hanson	11-103-57	Doxheimer well		153	153	"Jasper"

Published Data on Precambrian Wells in the Central Great Plains (Continued)

SOUTH DAKOTA (Continued)

Town	County	Sec. T. R.	Name	Elevation	Depth of Well	Depth Precambrian	Rock
Fort Randall					610	576	"Hard rock"
Hitchcock	Beadle	113- 63	Glidden well		1083-1142		Quartzite
					1142-1150	1083	Granite
Huron	Beadle	111- 62?			1139	1070	Quartzite on granite
Hillside	Douglas	18-100-62	County		1025	1025	Granite
Humboldt	Minnehaha	102- 52			153	140	Quartzite
Hurley	Turner	98- 53			510-513 or 556-559	510	Very hard rock
Irving	Spink	7-115-61	Motley		1050	1050	Very hard rock
Mitchell	Davison	18-102-61			280	280	Quartzite
Mitchell	Davison	25-102-62			280	280	Quartzite
Mitchell	Davison	17-103-61			312	312	Quartzite
Mitchell	Davison	29-104-60			228	228	Quartzite
Mitchell	Davison	25-104-60			115	115	Hard rock
Mitchell	Davison	103-60			765	540	Quartzite
Mitchell	Davison	25-103-61			500	500	Dk.-gray granite
Menno	Hutchinson	97-57			417	410	Sioux Falls quartzite
Milbank	Grant	120-48			303	280	Granite
Old Ft. James	Hanson	20-102-60			195	195	Quartzite
Pierre	Hughes	111-79?			1256	1250	Granite
Plankinton	Aurora	103- 64			830	745	Sioux Quartzite
Parker	Turner	100- 53			140	140	Quartzite
Parkston	Hutchinson	99- 60			522	510	Sioux Falls quartzite
Parkston	Hutchinson	99- 60			542	542	Sioux Falls quartzite
Raymond	Clarke	117- 59	Bohri		1200	1198	Quartzite on granite

Published Data on Precambrian Wells in the Central Great Plains (Continued)

SOUTH DAKOTA (Continued)

Town	County	Sec. T. R.	Name	Elevation	Depth of Well	Depth Precambrian	Rock
Riverside	Hanson	29-104-59?			100	100	Quartzite
Spencer	McCook	103- 56			100	100	"Jasper"
Salem	McCook	102- 54			170	170	Quartzite
Salem	McCook	103- 55			247	220	Sioux quartzite
Sioux Falls	Minnehaha	101- 49			575	0	Quartzite
Scotland	Bonhomme	96- 58			587	535	Quartzite
Tyndall	Bonhomme	94- 59			735	735	Quartzite
Verblen	Marshall	128- 53			860	860	Granite
Vermilion	Clay	92- 52	University well		630	630	Quartzite
Wolsey	Beadle	111- 64			930	928	"Very hard rock"
White Lake	Aurora	103- 66			900	900	Sioux quartzite
White Lake	Aurora	34-103-66	Heanneau's well		842	842	Sioux quartzite
West Point					300	300	Quartzite
Whiterock	Roberts	128- 47			500	500	Granite?
Yankton	Yankton	93- 56			942	898	"Granite"

OKLAHOMA

Town	County	Sec. T. R.	Name	Elevation	Depth of Well	Depth Precambrian	Rock
Big Cabin	Craig	24- 24-19		710			Granite
	Craig	34- 29-19		925		2200	Granite
Copan	Washington	30- 28-13	Rigdon Barnsdale		2560	2548	Hornblendite
Owen	Washington	22- 29-13	Thomason	775	3170	2500	Granite
Ochelata	Washington	25- 25-12		750		2250?	Granite

MISSOURI

Town	County	Sec. T. R.	Name	Elevation	Depth of Well	Depth Precambrian	Rock
Bonne Terre	St. Francois					635	Rhyolite granite
Carthage	Jasper		Harrington			1750	Crystalline rocks

Published Data on Precambrian Wells in the Central Great Plains and Central Interior (Cont'd.)

MISSOURI (Continued)

Town	County	Sec. T. R.	Name	Ele-vation	Depth of Well	Depth Precam-brian	Rock
Deerfield	Vernon					2000	Crystalline rocks
Jasper	Jasper						
Lamar							
Nevada	Vernon						
Rinehart	Vernon	30- 28-13	Decaturville Dome		3060		Crystalline rocks
Raytown	Jackson				2430	2348	Granite
Sullivan	Franklin				1200		Granite
St. Louis	St. Louis		Insane Asylum		3600		Precambrian rock

IOWA

Town	County	Sec. T. R.	Name	Ele-vation	Depth of Well	Depth Precam-brian	Rock
Algona	Kossuth	?- 95-29		1204	1860	1830	Archean rocks
Cedar Rapids	Linn	?- 83- 7			2150	2150	Hard Crystalline rocks
Holstein	Ida	?- 89-40			2040	2020	Archean (?)
Hull	Sioux	?- 97-45			755	755	Quartz porphyry
Lansing	Allanakee				751		Hard crystalline rock probably Huronian quartz
Sioux City	Woodbury	?- 89-47			1525	1510	Quartzite
					2071	1525	Granite or gneiss
Tipton	Cedar	?- 80- 2			2270	1820	Algonkian
Washington	Winneshiek	?- 98- 7		1100	3300	1720	Archean

years (see Figure 5). This cross section (Figure 5) shows that there is a separation between the downdropped block on the right, the Forest City Basin, and Table Rock Arch or Nemaha Arch on the west. What cannot be shown diagrammatically is the complexity of the faulting movements along the Humboldt Fault. The downdropping of the eastern block relative to Table Rock Arch has been accomplished in such a way that large slices or slivers of granite and related overlying sequences seem to have been stepped-faulted down to the east.

The interpretation of the geology of the basement complex for Kansas has been derived from data complied by Farquhar (1957) and from Merriam, Cole and Hambleton (1961). Information on the distribution of rock types in the basement complex of southeastern Nebraska has been compiled from data in the files of the Kansas Geological Survey through the courtesy of Dr. Hambleton. Of 19 wells within the state of Iowa drilled to the Precambrian only two are recorded within the area of special interest at the present time, namely in Fremont and Page Counties both of which encountered red clastics. These red clastics are considered to represent either granite wash resting on Precambrian granite or as is equally likely a feldspathic reddish variety of the Sioux quartzite.

The original geologic cross-section near the Kansas-Nebraska boundary published by the Nebraska Geological Survey showed only Precambrian granite beneath the rocks of Cambrian and Cambro-Ordovician age. In Figure 5 the writer has incorporated data of Farquhar (1957) which indicate that there are present between 97° and beyond 99° west longitude and also east of the Humboldt Fault and below the Forest City Basin, a sequence of metamorphic Precambrian rocks consisting of schist, phyllite, non-granitic gneiss and crystalline limestone. The Precambrian basement complex of the

entire area under consideration consists mainly of igneous and metamorphic rocks. The igneous rock most frequently recorded in wells is granite and the most frequently recognized metamorphic rocks of sedimentary origin are quartzite and schist. The overall distribution of rock types is only vaguely known despite the many control points in the form of wells. In Kansas alone, there are more than 2,000 control points but most wells are located along certain restricted structures, as for example, along the crest of the Nemaha or Table Rock Anticline and the Central Kansas Uplift. Since most of these wells are drilled for petroleum the identification of rock types is generalized. Vast areas of the region under consideration had no tests to the basement especially in basin areas.

Geology of the Central Great Plains, the Central Interior and the Front Range of the Rocky Mts.

Plate 2 (in pocket) shows the distribution of Precambrian basement rock types throughout the Central Great Plains, the Central Interior of the United States, the Black Hills, the Minnesota and Ozark Highlands and in the Front Range of the Rockies. Part of the information incorporated into this map is derived from surface observations but most of the area does not have surface exposures. Basement complex rocks are widely exposed in the Front Range, in the Black Hills, in the Minnesota and Wisconsin Uplands, in the Sioux Uplift and in the Ozark Uplift (Plate 3). Most of the information relating to the basement complex throughout the rest of the area is based on drill data. The best information available to the writer at present for any part of this area is that in the publications and files of the Kansas State Geological Survey. Most of the other published sub-surface data has been drawn from a variety of publications the most important ones being listed in the sources of information given on Plates 2 and 3.

An inspection of Plate 2 will reveal that most of the Great Plains and Central Interior regions are underlain by rocks of granite composition. The southern half of the Omaha area is underlain by granite and the northern portion by sediments including some quartzite, and one mafic igneous rock mass. The central portion of the map area is underlain by extensive deposits of Sioux quartzite and other undifferentiated metasediments. These areas include particularly the Salina Basin, the Central Kansas Uplift, a part of the Forest City Basin and the Central Iowa region (Plates 2 and 3). The Nemaha Uplift or Arch shows prominently on Plate 2 and is composed dominantly of granite with a few outlyers of quartzite and schist.

Plate 3, a tectonic map of the Central Great Plains, the Central Interior and the Front Range of the Rockies and adjacent regions shows the major structures within the larger map area, an understanding of which has a bearing upon the fuller comprehension of the geology of the Omaha area. An inspection of Plate 3 indicates that in the area of outcrop of Precambrian rock in the Rocky Mts., the Minnesota and Wisconsin Uplands and in the Ozark Uplift these rocks have been subjected to considerable faulting activity. It is clear also from Figures 4 and 5 and Plate 1 that the Nemaha Uplift and the Humboldt Fault zone are areas of intense tectonic activity of related type. Subsurface information reveals faulting only in exceptional cases. It will be noted that structures in the Kansas, Nebraska, South Dakota and Missouri regions have not only clear-cut northeasterly trends which are well known, but in addition strong northwesterly trends are conspicuous also, as for example in the Central Kansas Uplift, in the Cambridge Arch, the Chadron Arch and the Denton Arch.

The writer is of the opinion that there is probably a good deal of faulting associated with the northwesterly tectonic structures as well

as with the northeasterly trending features such as the Nemaha Arch. The basement complex there has undoubtedly been subjected to much more faulting activity than could possibly be suspected on the basis of subsurface information. The location of the problematic "Thurman-Wilson Fault" is shown on Plate 3. It will be noted that drill data west of the Nemaha Uplift confirms the inference from magnetic and gravity studies that there is a certain amount of mafic igneous rock west of the axis of the Uplift and that this location coincides with the Greenleaf positive anomaly.

Geophysical Data

The most important gravity maximum anomaly in North America and one which attains a relief of almost 140 milligals, Bouguer, traverses the Salina Basin of Kansas, extending northeastward through Nebraska, Iowa and into the Lake Superior area, and southward into Ok'ahoma. This anomaly is referred to commonly as the Greenleaf anomaly (Woollard, 1943). Figure 6 is a Bouguer Gravity Map showing the Greenleaf anomaly from Oklahoma to Wisconsin and Minnesota. This important geophysical feature is some 1,100 miles long and probably represents an extension of the sedimentary deposits of the Lake Superior syncline in a southwesterly direction through the Omaha area and into Kansas and Oklahoma. The gravity anomaly maximum coincides with prominent sedimentary basin areas. Figure 7 shows a magnetic, a gravity and a basement profile along the 40th parallel (Lyons, 1959 p. 119). The gravity profile of Figure 7 shows a cross-section from approximately 95° to 97° 30' along the 40th parallel. A density of 2.3 for topographic variation above sea level is assumed.

The profile by Woollard (1943) provides a quantitative approach to the extent and magnitude of the intrabasement mass giving rise to the anomaly. Combined with the magnetic profile of Figure 7 a base-

ment profile indicating general lithologic types and shapes of such masses is presented. The axis of a pronounced magnetic maximum coincides closely with the axis of the gravity maximum (Lyons, 1959 p. 108). Lyons points out that in the Lake Superior region the anomaly coincides with the Lake Superior syncline, a structure exhibiting a great thickness of Precambrian sedimentary rocks intruded by basic rocks. He concludes that through original composition, metamorphism, or intrusion of basic rocks, this prism of sediments would have acquired a density in excess of normal and sufficient to cause the gravity anomaly in that area. He concludes that a similar basement rock distribution should persist southwestward from Lake Superior through Iowa, Nebraska, Kansas and into Oklahoma since the gravity anomaly is continuous. It will be noted in Figure 7 that the Nemaha Arch or Uplift, although topographically high shows both a gravity low and a relatively low magnetic value as compared to both the west "band" and the east "band". Lyons (1959 p. 111) concludes that the Nemaha range in general occupies a "faded gravity minimum". He attributes this to the fact that the granite in wells penetrating the basement Uplift has no appreciable density contrast with the overlying sediments. The Nemaha structure does not display gravity maxima other than those associated with the uplift of denser sediments into lighter sediments. As a result the Nemaha gravity anomalies are faint and can be isolated as residual anomalies only after regional effects are removed. Lyons concludes that the gravity anomaly and steep gradients along the 40th parallel require that the rocks have a density contrast of 0.3 or 0.4 at a depth as shallow as the basement surface and having a downward continuation. He concludes that only basic igneous rocks satisfy these requirements. This positive feature must have a width of about 33 miles. Jensen's (1949) study of the magnetics along the 40th parallel leads to the conclusion that the basement profiles (Figure 7) show the uplifted, less dense cen-

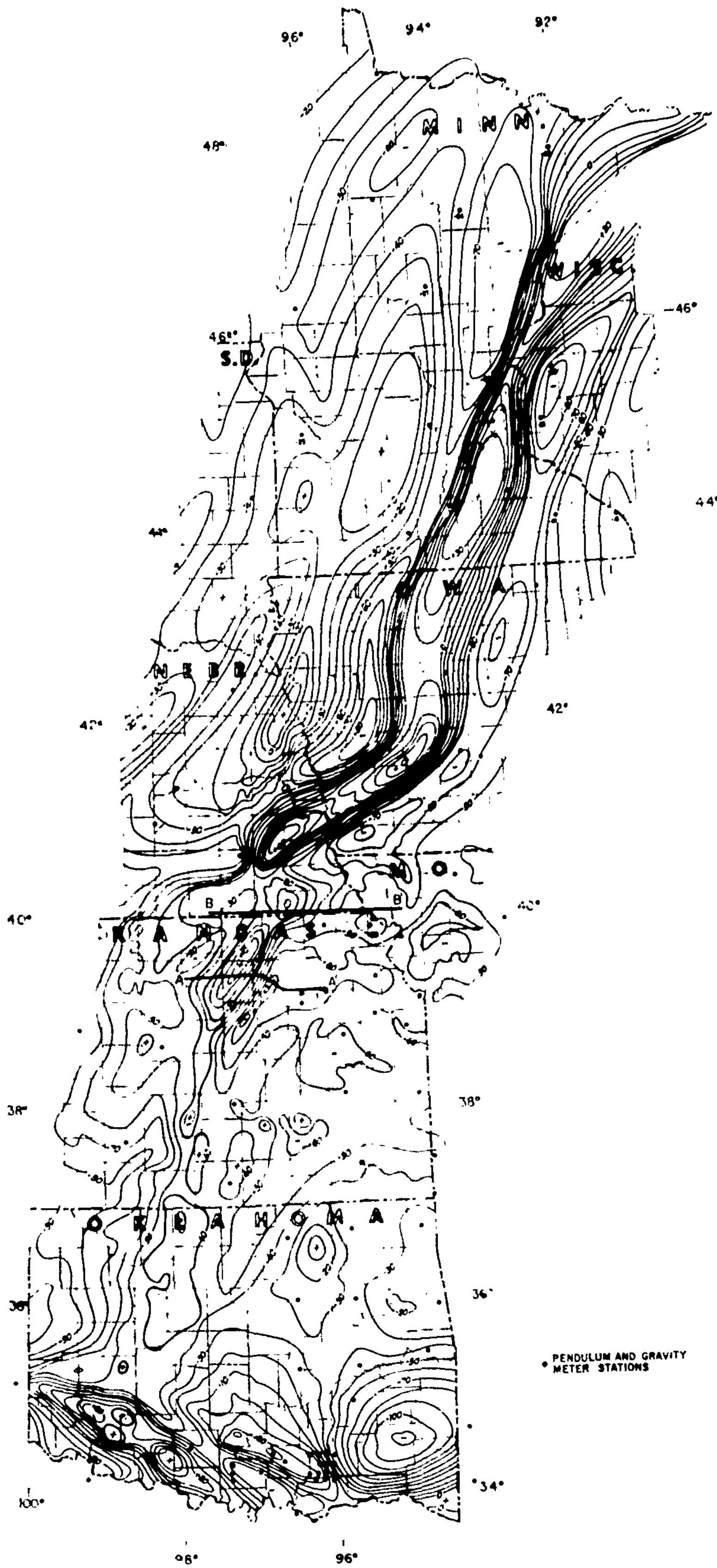

FIG. 6 BOUGUER GRAVITY MAP SHOWING GREENLEAF ANOMALY, CONTOUR INTERVAL 10 MILLIGALS — (FROM STATE GEOL. SURV. OF KANSAS, BULL. 137, 1959, P. 106)

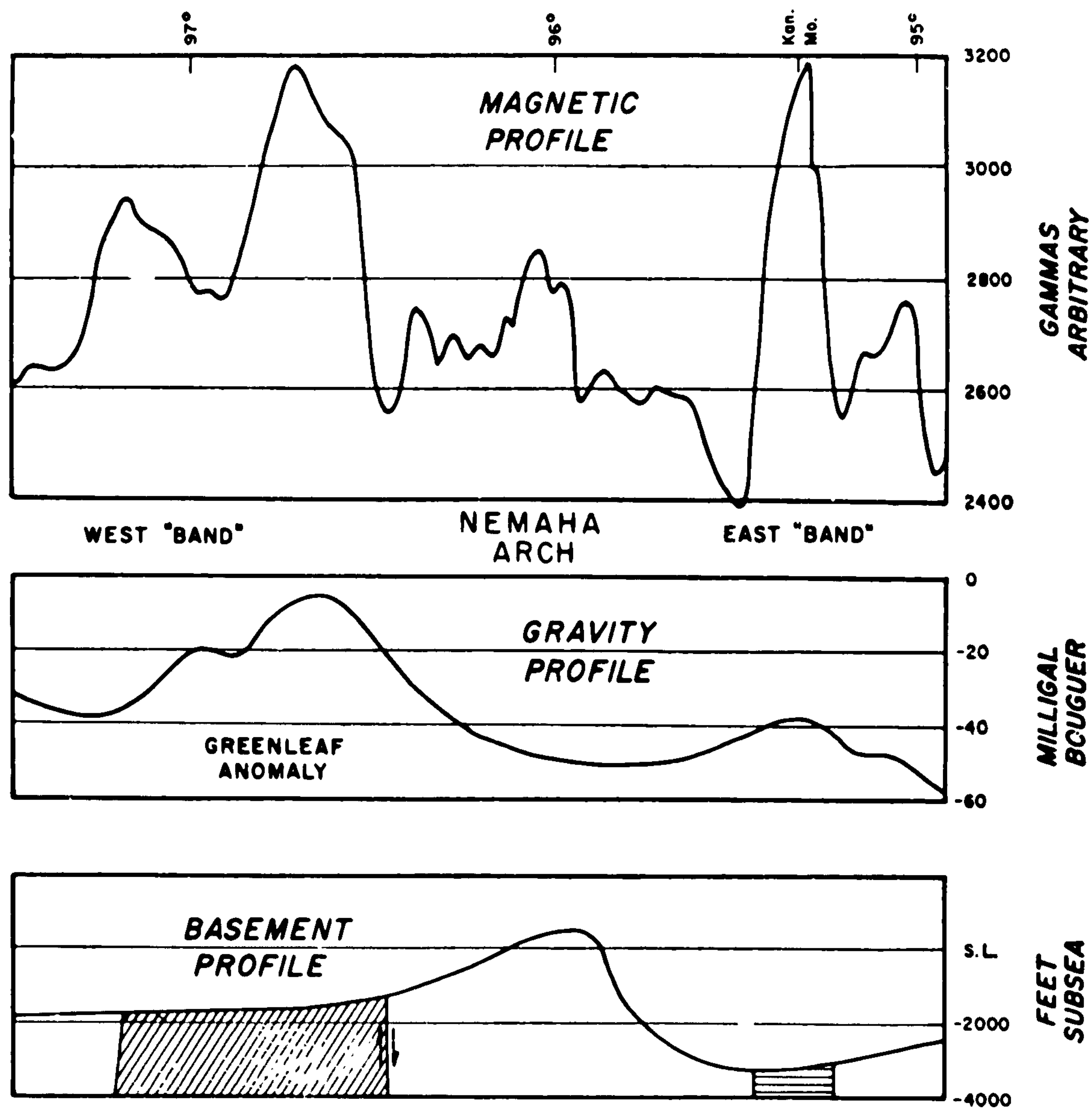

FIG. 7 MAGNETIC, GRAVITY, AND BASEMENT PROFILES ALONG NORTH LINE (40TH PARALLEL) OF KANSAS — (FROM STATE GEOL. SURV. OF KANSAS, BULL. 137, 1959, P. 119)

tral mass of the Nemaha Arch as lying between belts of faulting and zones of basic intrusion.

Earthquake Activity in the Omaha Area

Figure 8 is a map showing the distribution of earthquake epicenters in the United States through 1957 (Woollard, 1958a), as well as positive gravity anomaly arcs. (Lyons,1959 p. 109). This map shows the location of recurrent earthquake activity in relationship to positive gravity anomalies. While the Greenleaf anomaly does not have earthquake epicenters clustered along it in the same degree as does the California, Oregon, Washington one, nevertheless in the Nebraska, Kansas and Oklahoma areas there is a definite correlation between the anomaly and the distribution of earthquake epicenters. It is clear from the geologic record that the Nemaha Arch has been recurrently active, seismicly speaking, from Precambrian time to the present. The writer concludes therefore that adjustment within the Earth's crust along the Greenleaf anomaly and in association with the Nemaha Arch is a factor that should be taken into consideration in any engineering project in the Omaha area particularly if there is question of a deep subsurface installation.

Deep Resistivity Data

Cantwell (1962) has investigated the resistivity of the surface layer and of the Precambrian basement in the Omaha region. During November 1962 deep resistivity measurements were made near Auburn, Nebraska. It was previously thought that the surface layer has a resistivity of 10 ohm-meters and was about 500' thick. The basement complex constituted the second layer and measurements were conducted to determine the resistivty of this layer. These studies indicated that the thickness of the upper layer is approximately 500'

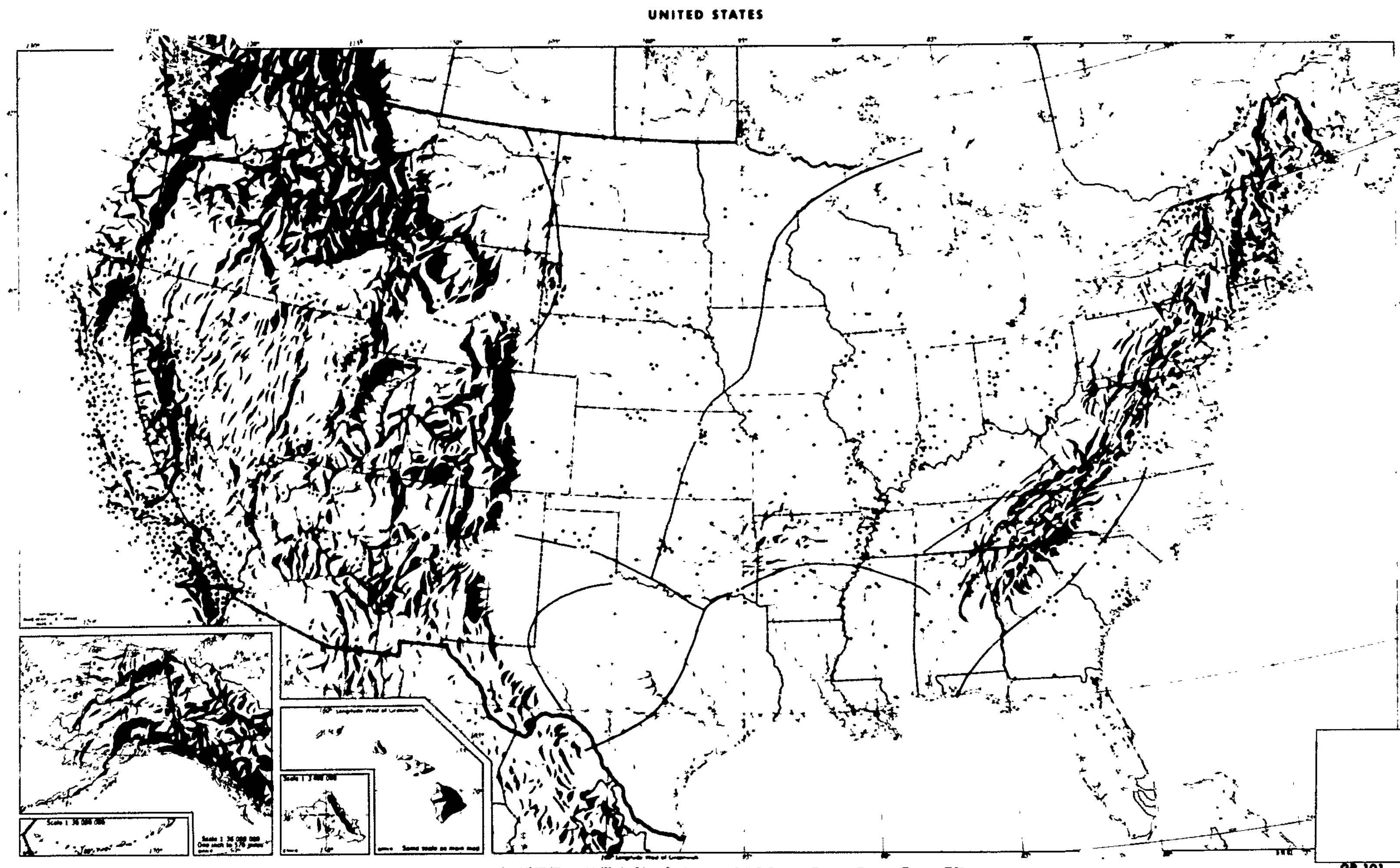

FIG. 8. EPICENTER MAP OF THE UNITED STATES WITH POSITIVE GRAVITY ANOMALY ARCS

TAKEN FROM P. L. LYONS (1959), STATE GEOLOGICAL SURVEY OF KANSAS BULL. 137, P. 109

with a resistivity contrast of 10:1. The upper layer gave resistivity values of 15-20 ohm-meters, with the average resistivity of the basement complex being 150-200 ohm-meters. Taking into consideration the known geology, an upper limit of 800-1,000 ohm-meters is placed on the hidden layer resistivity which might cause deviation from the model which Cantwell assumes. His conclusion drawn from his deep resistivity studies is that the Precambrian basement is not suitable for deep strata communication for the upper kilometer, and there is no evidence for a increase in resistivity below this point.

Engineering Geology, Conclusions and Recommendations

In the light of all available geological and geophysical data the writer concludes that the Precambrian basement complex in the Omaha area and in particular in Pawnee and Johnson Counties is poorly suited to deep strata communication and to the construction of deep underground installations. Engineering problems of great magnitude would be predicted on the basis of the highly faulted and shattered character of the basement complex along the east side of the Nemaha Arch and in the vicinity of the Humboldt Fault zone. Several fault slices have been recognized on the basis of a relatively small number of drill holes. These faults together with the fact that there are certain water-bearing formations closely associated with the basement complex, as for example the St. Peter sandstone (Figure 4), indicate that engineering problems would be multiplied. A further consideration is that the epicenter map (Figure 8) suggests that the Greenleaf anomaly and the associated Nemaha Arch and the Humboldt Fault have been at least somewhat active during the time of relatively recent earthquake recordings and there is no suggestion that such seismic activity has complete-

ly ceased in this area. These facts prompt the writer to conclude that the Omaha area is poorly suited for both deep strata communication and for deep underground facility installation.

REFERENCES

Adams, J. W., (1959) Rocks of the Precambrian basement and those immediately overlying it in Missouri and parts of adjacent states: Unpublished M.S. Thesis, Univ. of Missouri, 342 p.

Agocs, W. B., (1959) Comparison of basement depths from aeromagnetics and wells along the northern border of Kansas, in Hambleton, W. W., ed., Symposium on Geophysics in Kansas, Bull. 137, Kans. St. Geol. Survey, pp. 143-152.

_______, (1959) Airborne magnetometer profiles, Morris and Wabaunsee Counties, Kansas, in Hambleton, W. W., ed., Symposium on Geophysics in Kansas, Bull. 137, Kans. St. Geol. Survey, pp. 175-180.

Anderson, K. E., (1950) Basement complex biotite granite at Dubuque, Iowa: Proc. Iowa Acad. Sci., v. 57, pp. 241-245.

Baker, C. L., (1947) Deep borings of western South Dakota: S. Dak. Geol. Survey Rpt. Inv. no. 57, 112 p.

Baldwin, B., (1949) A preliminary report on the Sioux quartzite; S. Dak. Geol. Survey Rpt. Inv. no. 63 34 p.

Barkley, R. C., (1953) Artesian conditions in area surrounding the Sioux quartzite ridge: S. Dak. Geol. Survey Rpt. Inv. no. 72, 68 p.

Carlson, M. P., (1961) Contour map of Precambrian surface in Nebraska: Univ. Nebr. Conserv. and Survey Div., Nebr. Geol. Survey.

Cole, V. B., Merriam, D. F., Franks, P. C., Hambleton, W. W., and Hilpman, P. L., (1961) Wells drilled into Precambrian rock in Kansas: Bull. 150, Kans. Geol. Survey, 169 p.

_______, (1962) Configuration of top of the Precambrian basement rocks in Kansas: Kans. St. Geol. Survey Oil and Gas Inv. no. 26.

Condra, G. E., (1939) Correlation of the Amerada Petroleum Company well drilled near Nehawka, Nebraska: Nebr. Geol. Survey Paper 14, 16 p.

_______, and Reed, E. C., (1939) Deep wells at Lincoln, Nebraska: Nebr. Geol. Survey Paper 15, 25 p.

Farquhar, O. C., (1957) The Precambrian Rocks of Kansas: Bull. 127, Kans. Geol. Survey, pt. 3, pp. 49-122.

Fath, A. E., (1920) The origin of the faults, anticlines, and buried "granite ridge" of the northern part of the Mid-Continent oil and gas field: U. S. Geol. Survey Prof. Paper 128, pp. 75-84.

Fenneman, N. M., (1931) Physiography of Eastern United States: McGraw-Hill Book Co. 714 p.

Gould, C. N., (1923) Crystalline rocks of the Plains: Bull., Geol. Soc. Amer., v. 34, pp. 541-560.

Grenia, J. D., (1960) Precambrian topography and rock types: Missouri Geol. Survey and Water Resources Map.

Heinrich, R. R., (1955) Earthquakes and structural trends in the central stable region of the North American Continent, pt. 1 Regional Consideration; pt. 2, The New Madrid area, Missouri: Earthquake Notes, v. 26, pp. 7-8 and pp. 16-20.

Ireland, H. A., (1955) Precambrian surface in northeastern Oklahoma and parts of adjacent states: Bull., Am. Assoc. Petrol. Geol., v. 39, pp. 468-483.

Jensen, Homer (1949) Airborne Magnetic Profile above 40th Parallel eastern Colorado to western Indiana: Geophysics, v. 14, no. 1, 57 p.

King, E. R., (1959) Two aeromagnetic profiles across western Kansas, <u>in</u> Hambleton, W. W., ed., Symposium on Geophysics in Kansas, Bull. 137, Kans. St. Geol. Survey pp. 135-141.

Landes, K. K. (1927) A Petrographic study of Precambrian in Kansas: Bull., Am. Assoc. Petrol. Geol., v. 11, pp. 821-824.

Lange, A. J. and Ver Wiebe, W. A., (1954) Unusual rock in Hodgeman County, Kansas: Univ. of Wichita, Univ. Studies no. 30, 3 p.

Lee, K. Y., (1957) Some hydrothermal effects in a volcanic rock from a well boring, Sanborn County, South Dakota: S. Dak. Acad. Sci. Proc., v. 36, pp. 117-122.

Ley, H. A. (1926) The granite ridge of Kansas: Bull., Am. Assoc. Petrol. Geol., v. 10, pp. 95-96.

Lum, D., (1961) Gravity measurements east of the Black Hills and along a line from Rapid City to Sioux Falls, South Dakota: S. Dak. St. Geol. Survey Rpt. Inv. no. 88, 26 p.

Lyons, P. L., (1950) A gravity map of the United States: Tulsa Geol. Soc. Digest, v. 18, pp. 33-43.

_______, (1959) The Greenleaf anomaly, a significant gravity feature in Hambleton, W. W., ed., Symposium on Geophysics in Kansas: Bull. 137, Kans. St. Geol. Survey, pp. 105-120.

Merriam, D. F., and Hambleton, W. W., (1959) Exploration Geophysics in Kansas, in Hambleton, W. W., ed., Symposium on Geophysics in Kansas: Bull. 137, Kans. St. Geol. Survey, pp. 53-62.

_______, and Hambleton, W. W., (1959) Relation of magnetic and aeromagnetic profiles to geology in Kansas, in Hambleton, W. W., ed., Symposium on Geophysics in Kansas: Bull. 137, Kans. St. Geol. Survey, pp. 153-173.

_______, Cole, V. B., and Hambleton, W. W., (1961) Distribution of Precambrian basement rock types in Kansas: Bull., Am. Assoc. Petrol. Geol., v. 45, pp. 2018-2024.

_______, Cole, V. B., and Hambleton, W. W., (1962) Precambrian basement rock types in the Mid-Continent region (Abs.): Bull., Am. Assoc. Petrol. Geol. v. 46, 272 p.

Mettner, F. E., (1936) The Precambrian basement complex of Kansas: Unpublished M.S. Thesis, Kans. Univ., 59 p.

Moore, R. C., (1920) The relation of the buried granite in Kansas to oil production: Bull., Am. Assoc. Petrol. Geol. v. 4, pp. 255-261.

Moss, R. G., (1936) Buried Precambrian surface in the United States: Bull., Geol. Soc. Am. v. 47, pp. 935-966.

Powers, Sidney, (1917) Granites in Kansas: Am. Jour. Sci., ser. 4, v. 44, pp. 146-150.

Reed, E. C., (1938) Correlation of formations drilled in the Midland Forster Well near Fremont, Nebraska: Nebr. Geol. Survey Paper 13, 20 p.

Schramm, E. F., (1931) Precambrian wells, in Condra, G. E., Schramm, E. F., and Lugn, A. L., Deep wells in Nebraska: Bull. 4, Nebr. Geol. Survey, 2d ser., pp. 281-286.

Taylor, C. H., (1917) The granites of Kansas: Bull., Southwestern Assoc. Petroleum Geologists, v. 1, pp. 111-126.

Twenhofel, W. H., and Edwards, E. C., (1921) The metamorphic rocks of Woodson County, Kansas: Bull., Am. Assoc. Petrol. Geol. v. 5, pp. 64-74.

Woollard, G. P., (1943) Transcontinental Gravitational and magnetic profile of North America and its relation to geologic structure: Bull., Geol. Soc. Am. v. 54, pp. 747-790.

_______, (1958) Results for a gravity control network at airports in the United States: Geophysics, v. 23, no. 3, pp. 520-535.

_______, (1958a) Areas of tectonic activity in the United States as indicated by earthquake epicenters: Amer. Geophys. Union Trans. v. 39, pp. 1135-1150.

_______, Trans. A. G. U. v. 39, pp. 1142-1143.

_______, (1959) The relation of gravity to geology in Kansas, in Hambleton, W. W., ed., Symposium on Geophysics in Kansas: Bull. 137, Kans. St. Geol. Survey, pp. 63-103.

Appendix 1

Organizations or individuals who have made special studies relating to or who have made compilations of data bearing upon the depth to and nature of the basement complex in the Omaha area in particular or the Central Great Plains and adjoining regions in general.

Geological Data

Dr. Eugene C. Reed, Director, Nebraska Geological Survey, Conservation and Survey Division, University of Nebraska, Lincoln, Nebraska.

Kansas State Geological Survey: Dr. Frank C. Foley, Director; Virgil B. Cole, Chairman of Kansas Basement Rocks Committee; Dr. William W. Hambleton; Dr. Daniel F. Merriam.

Dr. William E. Ham; Miss Louise Jordan, Oklahoma Geological Survey, Norman, Oklahoma.

S. M. Genensky and R. L. Loofbourow, The Rand Corporation, 1700 Main Street, Santa Monica, California.

Mr. Maurice E. Kirby, Consulting Geologist, Omaha, Nebraska.

Committee for the Compilation of Basement Rock Map for North America, between 24° and 60° N. latitude.

Dr. Peter G. Flawn, Chairman, Basement Rocks Project Committee of North America, The American Association of Petroleum Geologists, University Station, Box 8022, Austin, Texas.

Prof. William R. Muehlberger, Drs. Edward G. Lidiak and R. E. Denison, Crustal Studies Laboratory, Balcones Research Center, University of Texas, Austin, Texas.

Geophysical Data for the Great Plains and the Gulf Coast

Mr. Benjamin F. Rummerfield, President, GEODATA Corporation, Thompson Building, Tulsa, Oklahoma, Telephone Luther 4-3366.

Bedrock Information for Oklahoma

Mr. Jerry Champlain, U. S. Bureau of Mines, Bartlesville, Oklahoma.

General Compilers of Information on the Geology and Geophysical Characteristics of the Basement Rocks of various parts of North America.

S. Benedict Levin, Deputy Director, Institute for Exploratory Research, U. S. Army Signal R. & D. Laboratory, Fort Monmouth, New Jersey, Telephone 201-535-1308.

Dr. John E. Galley, Chairman, The American Association of Petroleum Geologists Research Committee, Subcommittee on Atomic Waste Disposal, P. O. Box 1509, Midland, Texas.

Seismological Data for certain portions of the Great Plains and Central Interior.

Dr. James Peoples, Department of Geology, University of Kansas, Lawrence, Kansas.

Dr. Donald H. Hase, Department of Geology, State University of Iowa, Iowa City, Iowa.

Source of Information on average conductivity and resistivity values of the basement complex of the Mid-West.

Mr. Charles Miller, Slumberger Company, Wichita, Kansas.

Dr. George Keller, U. S. Geological Survey, Federal Center, Denver, Colorado.

Prof. Thomas Cantwell, Prof. Theodore R. Madden, and Mr. E. N. Dulaney, Geoscience Incorporated, P. O. Box 175, Lexington 73, Massachusetts, Telephone 617-862-0543.

Basement Complex of the Rocky Mountains

Mr. Gilmore Hill, Denver Research Corporation, Denver, Colorado.

Mr. Chet Thomas, Los Angeles, California.

Electrical or Radioactivity Log Library, Kansas Well Log Bureau, 508 East Murdock Street, Wichita, Kansas.

Petroleum Information, 1640 Grant, Denver, Colorado.

Reilly's, 1540 Glenarm Place, Denver, Colorado (for drill records in central and western Nebraska).

Basement Information in Iowa

Dr. H. Garland Hershey, Director and State Geologist, Iowa Geological Survey, Geological Survey Building, Iowa City, Iowa.

Best Single Source of Information on the Nature of the Bedrock in the Great Plains Area

Virgil B. Cole, Consulting Geologist, 207 N. Parkwood Lane, Wichita 8, Kansas; Chairman, Kansas Basement Rocks Committee, Kansas Geological Survey, Lawrence, Kansas.

UNCLASSIFIED

AF Cambridge Research Laboratories, Bedford, Mass.
GEOLOGY OF THE BASEMENT COMPLEX OF SOUTH-EASTERN NEBRASKA, NORTHEASTERN KANSAS AND VICINITY, by James W. Skehan, S.J., July 1963. 57 pp.
AFCRL-63-173 Unclassified report

1. Regional Tectonics
2. Underground Radio Communication

I. Skehan, S.J., J.W.

The Precambrian basement complex rocks of this area consist of granite and metasediments. These form a highly faulted topographic and structural ridge, the Nemaha Arch. The east side of the arch is down-faulted at least 2,600 feet. All available geological and geophysical data indicate that this area is unsuitable for both deep underground radio communication and deep underground facility installation.

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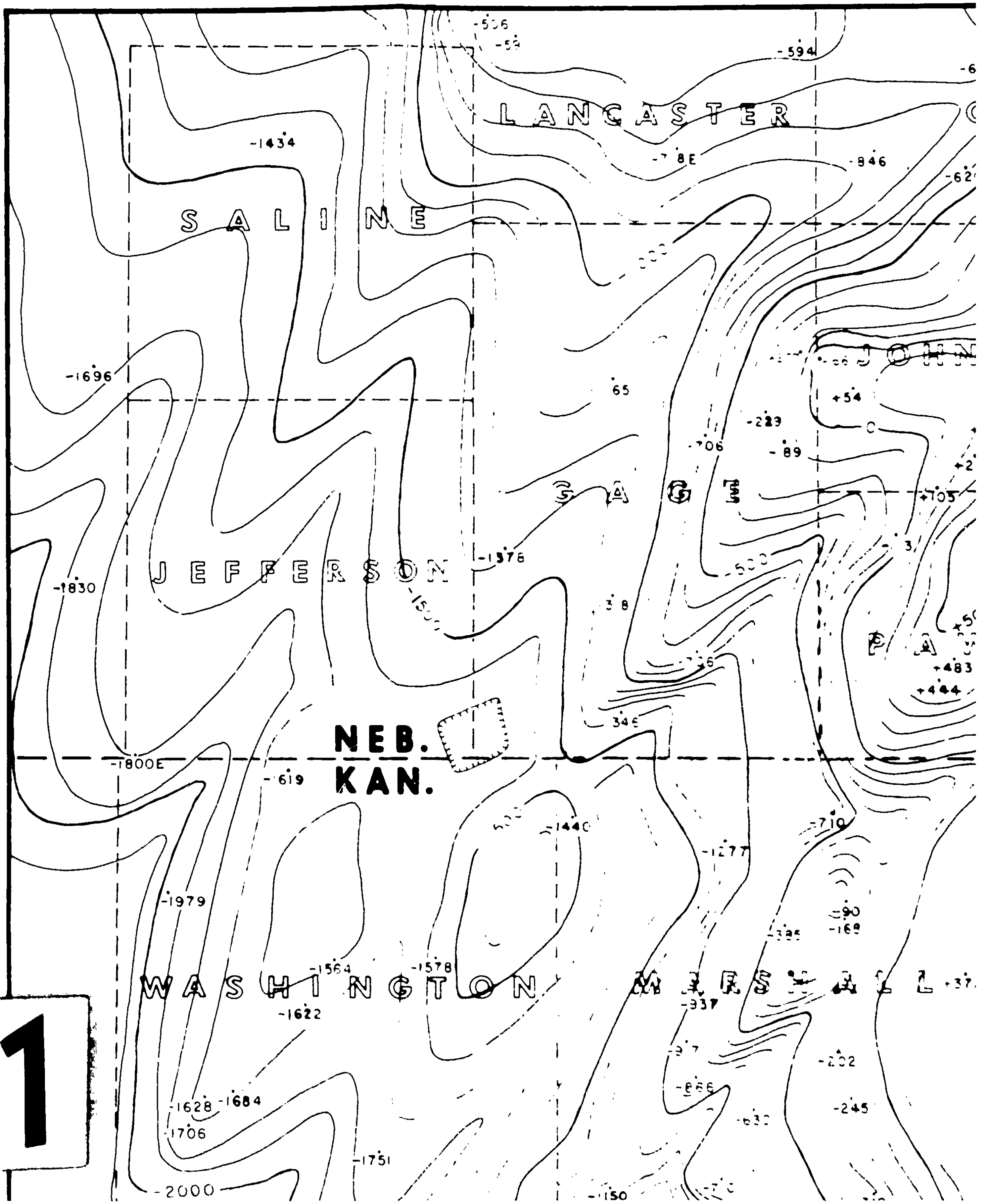
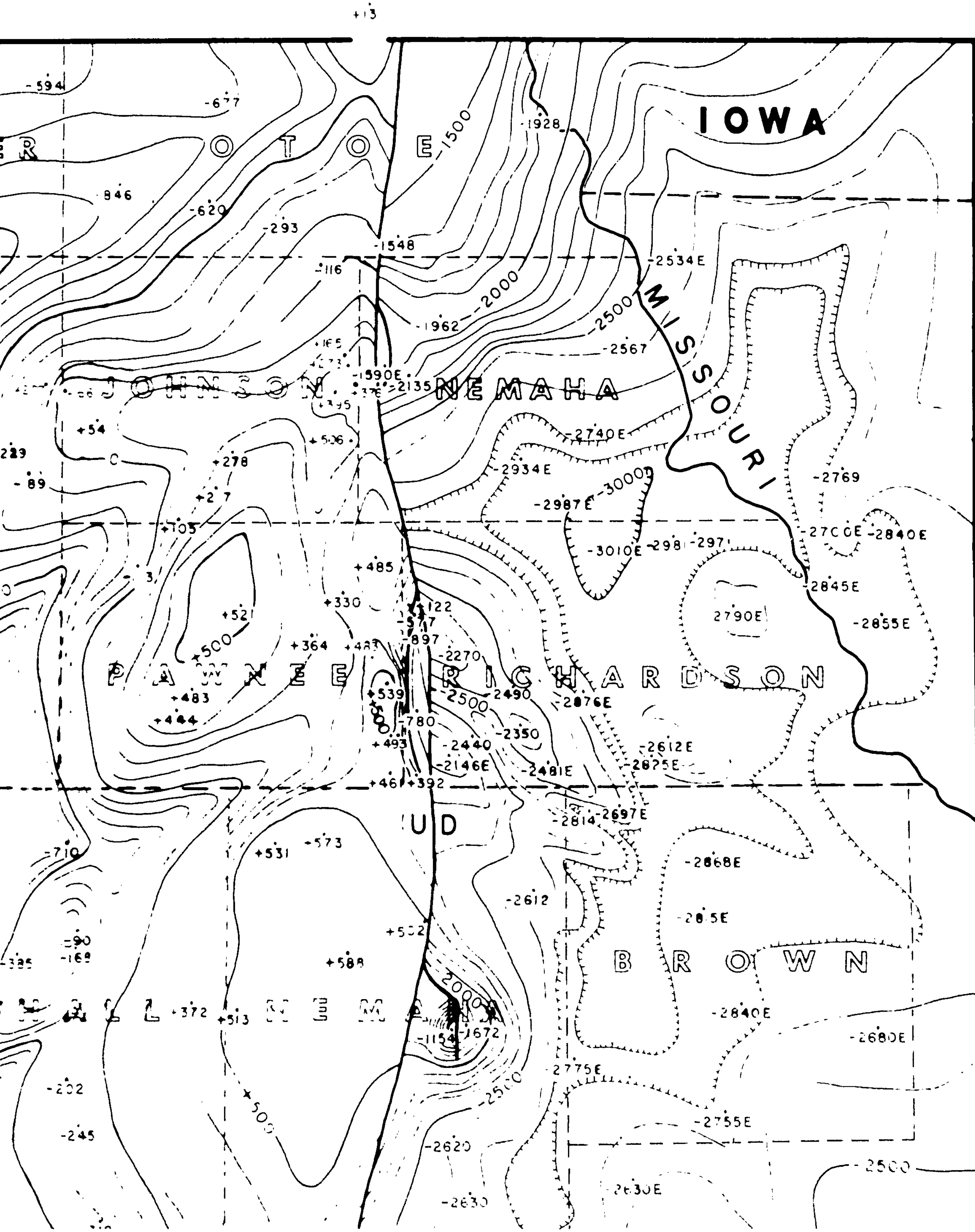
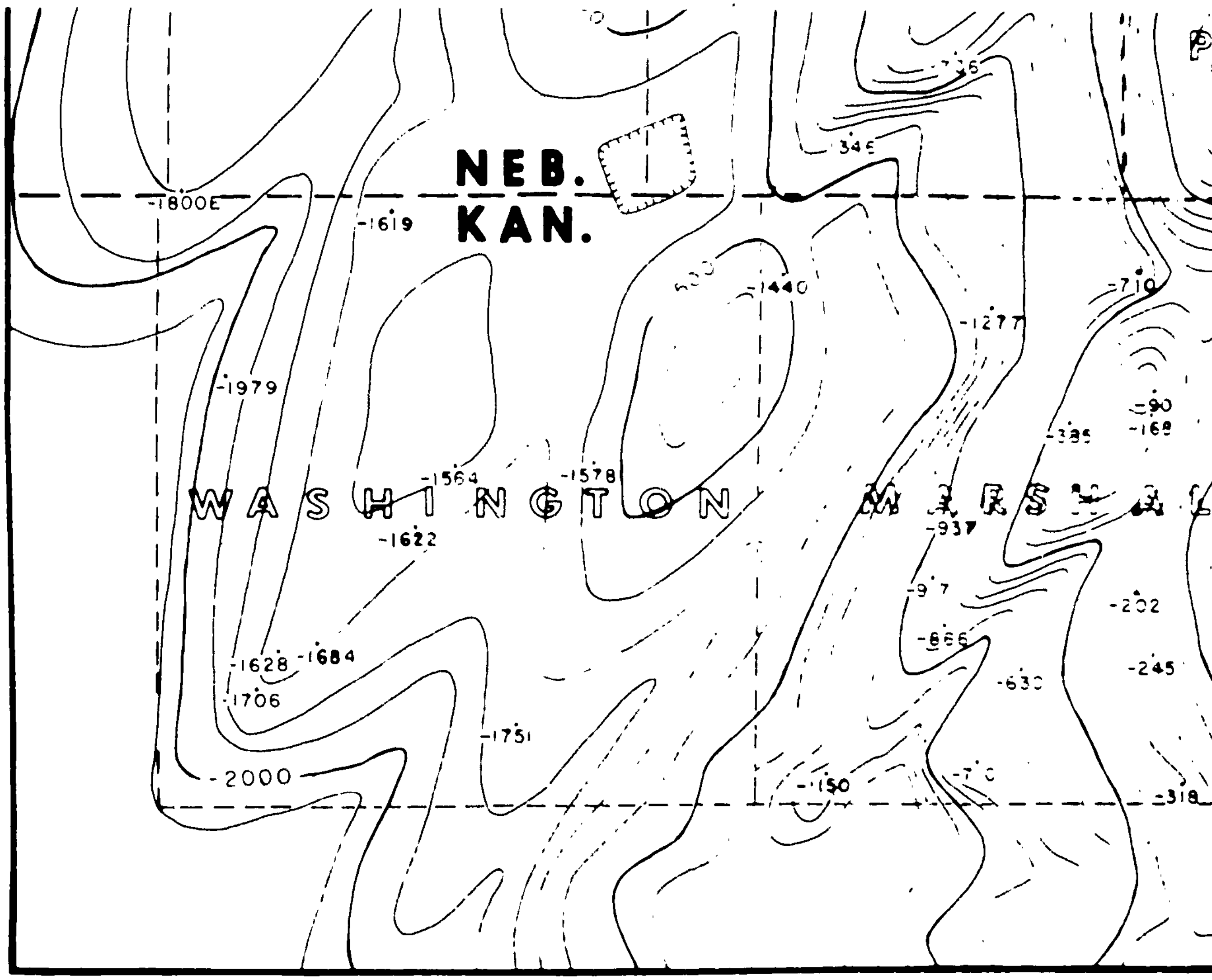


LANCASTER
SALINE
JOHNSON
GAGE
JEFFERSON
PAWNEE
NEB.
KAN.
WASHINGTON
MARSHALL
-1434
-594
-846
-1696
65
-229
-706
-89
+54
+105
-1378
-1830
+483
+444
346
-1800E
-619
-1440
-1277
-710
-1979
-90
-169
-1564
-1578
-1622
-337
-202
-1628
-1684
-1706
-245
-1751
-2000
-150

1


IOWA
MISSOURI
OTOE
JOHNSON
NEMAHA
PAWNEE
RICHARDSON
BROWN
1500
2000
2500
3000
-1928
-1548
-1962
-2534E
-2567
-2740E
-2934E
-2987E
-3010E
-2769
-2845E
-2855E
2790E
-2876E
-2612E
-2868E
-2840E
-2680E
-2775E
-2755E
-2620
-2630
+485
+330
+521
+364
+483
+444
+539
+493
+392
+531
-573
+588
+372
+513
-710
-245
-594
-293
-620
+278
+54
-89

2



CONFIGURATION OF TH
OF SOUTHEASTERN NEBRASK
AND ADJOINI

UNPUBLISHED MAP BY VIRGIL
E.G. LIDIAK AND WITH MODIFICAT

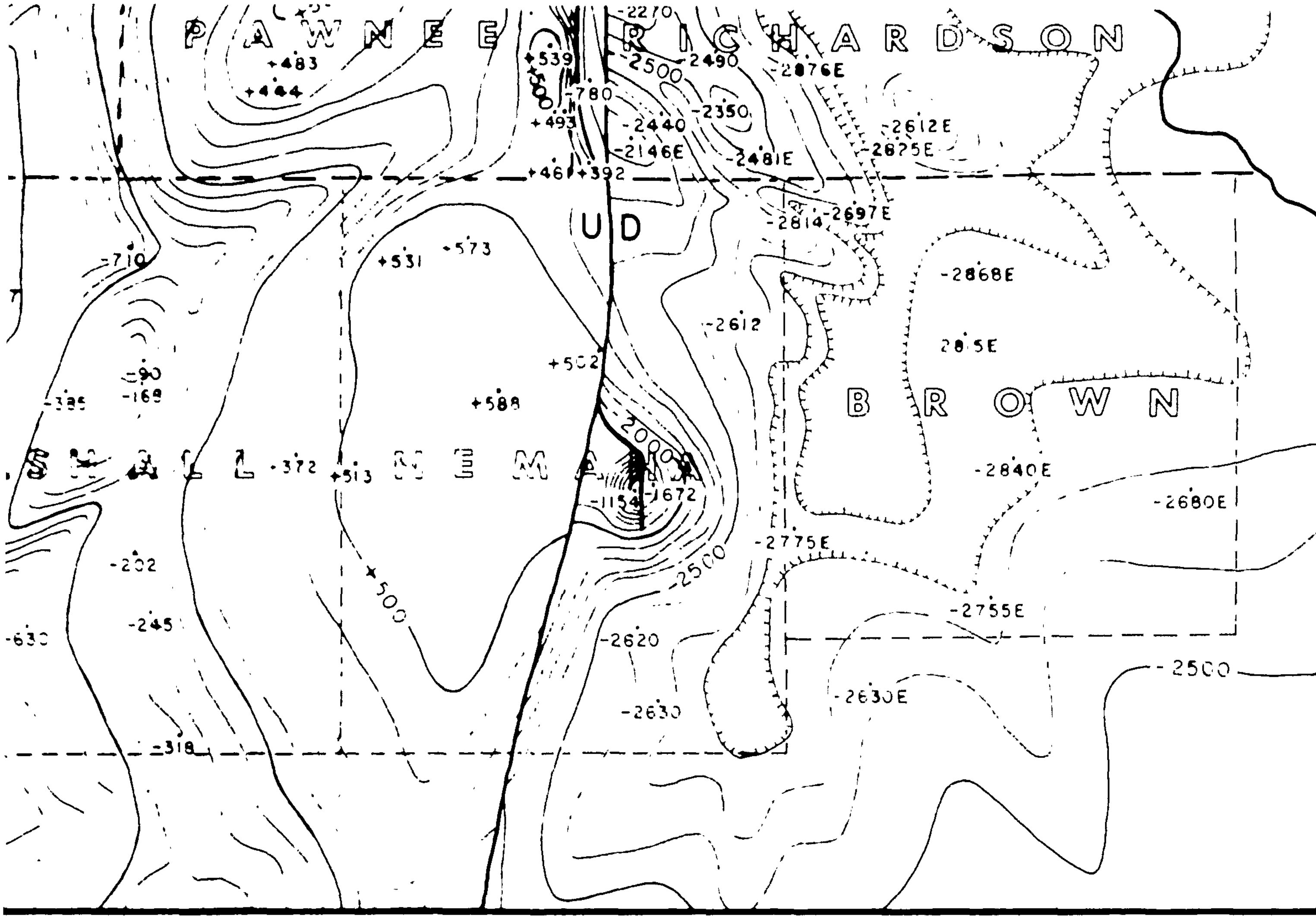
SCALE

10 0 10 20 30 40 MI

CONTOUR INTERVAL 100 FT.

3

ALL NUMBERS INDICATE ELEVATIONS OF THE SURFAC



OF THE BASEMENT COMPLEX
BRASKA, NORTHEASTERN KANSAS
JOINING STATES

/IRGIL B. COLE 1962., WITH DATA FROM
IFICATIONS BY J. W. SKEHAN S.J.

40 MILES

FT.

LEGEND

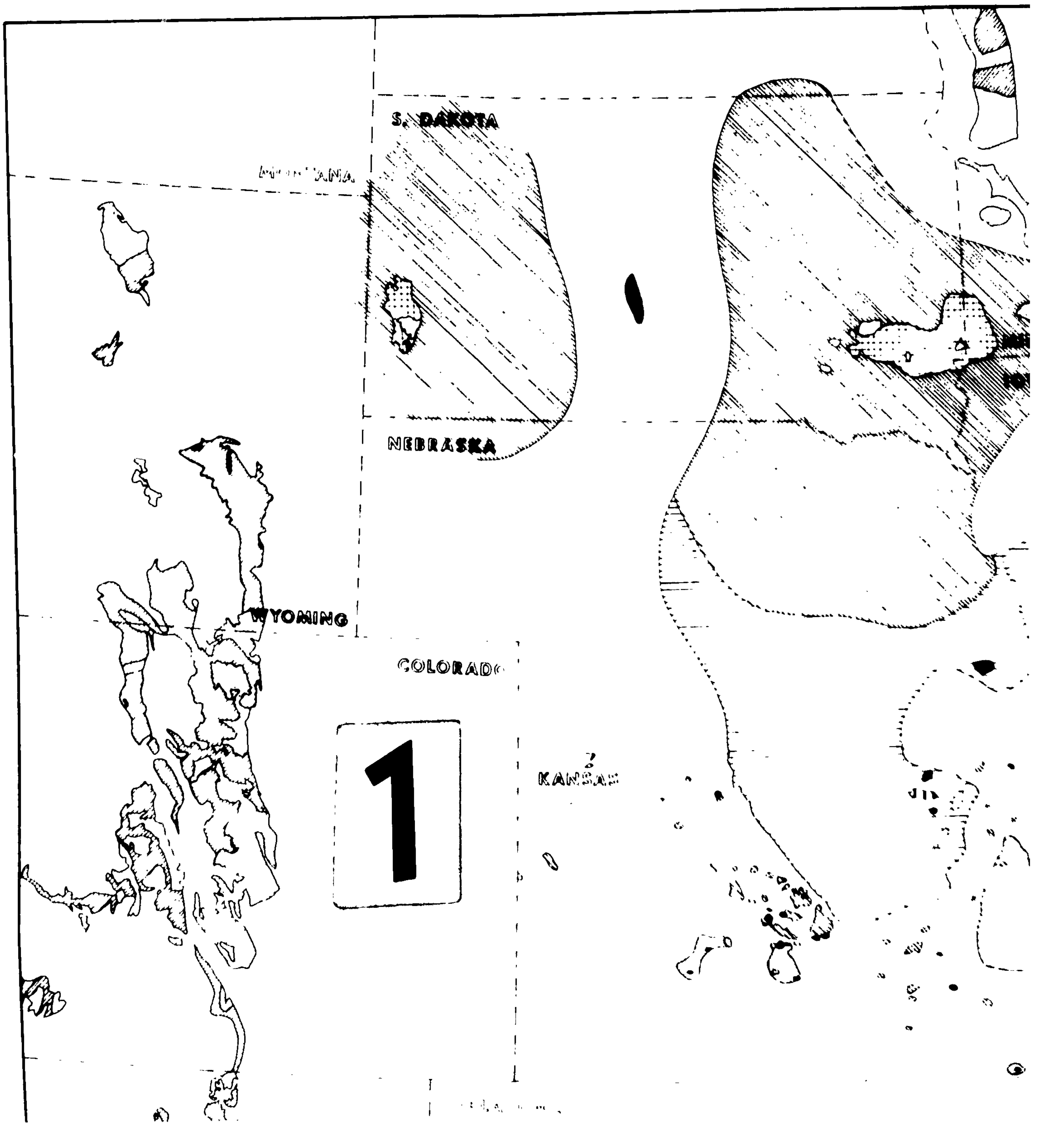
U D — FAULT

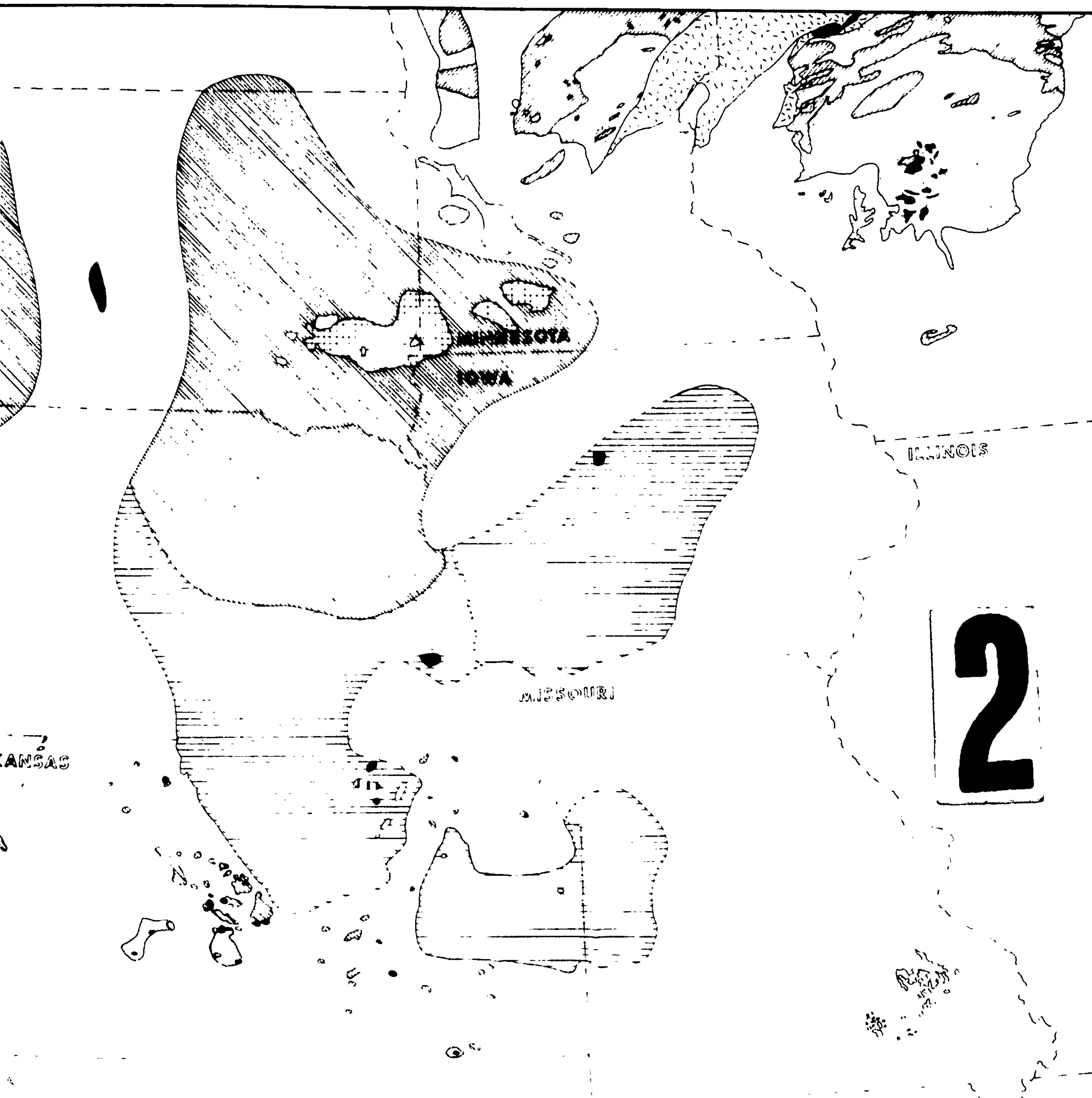
2755E — EXTRAPOLATED ELEVATION

THE SURFACE OF BEDROCK IN FEET BASED ON DRILLING DATA

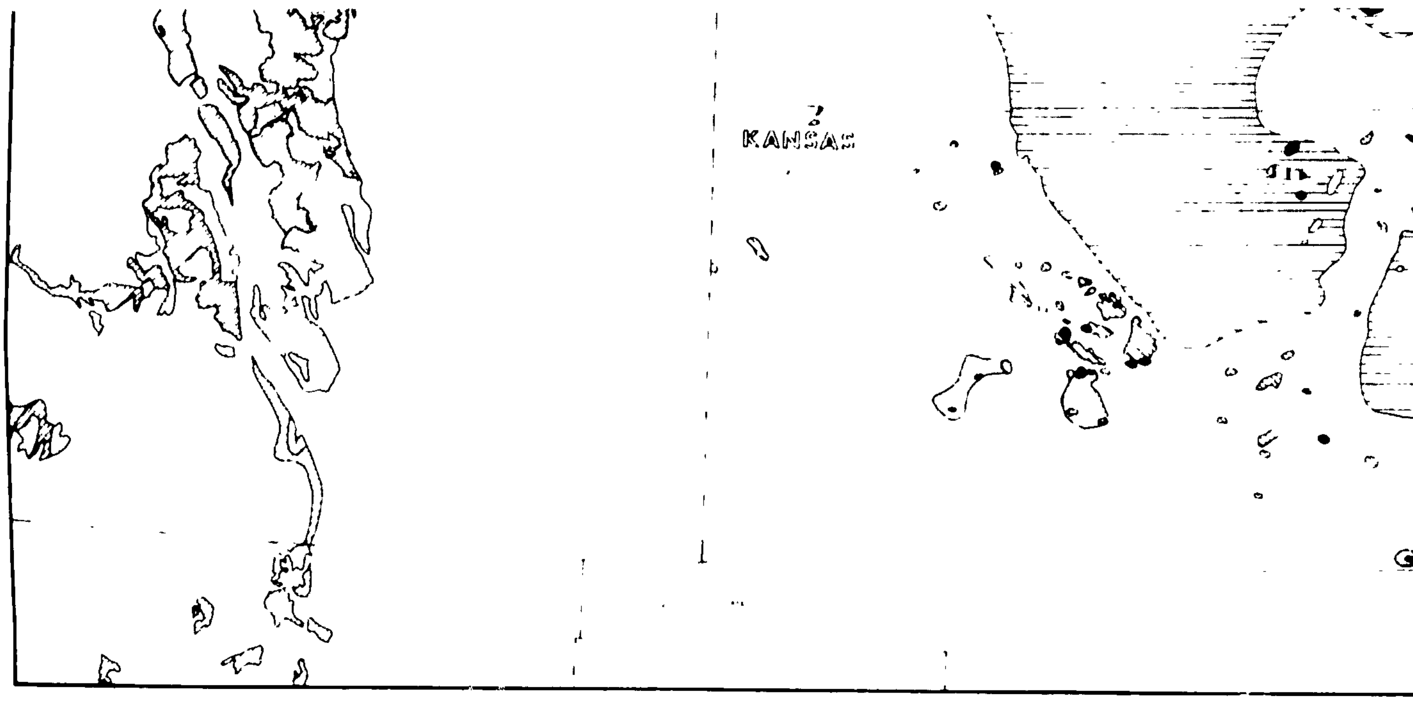
4

PLATE 1


S. DAKOTA
NEBRASKA
WYOMING
COLORADO
KANSAS
1



MINNESOTA
IOWA
ILLINOIS
MISSOURI
KANSAS
2



PRECAMBRIAN BASEMENT ROCK TYPES IN THE CENTRAL (
AND FRONT RANGE

by James W Skehan S.J

SCALE

MILES

LEGEND

SUBSURFACE LITHOLOGIES

- METASEDIMENTS
- QUARTZITE (AND SCHIST OUTLIERS)
- EXTRUSIVE ROCK
- INFERRED EXTRUSIVE
- GRANITE
- GRANODIORITE
- MAFIC IGNEOUS ROCK

SURFACE LITHOLOGIES

- GRANITE AND OTHER INTRUSIVE ROCKS
- SCHIST, GNEISS, AND QUARTZITE
- QUARTZITE
- SEDIMENTARY ROCKS

SOURCES OF INFOR

SUBSURFACE KANS

NEBF

IOWA

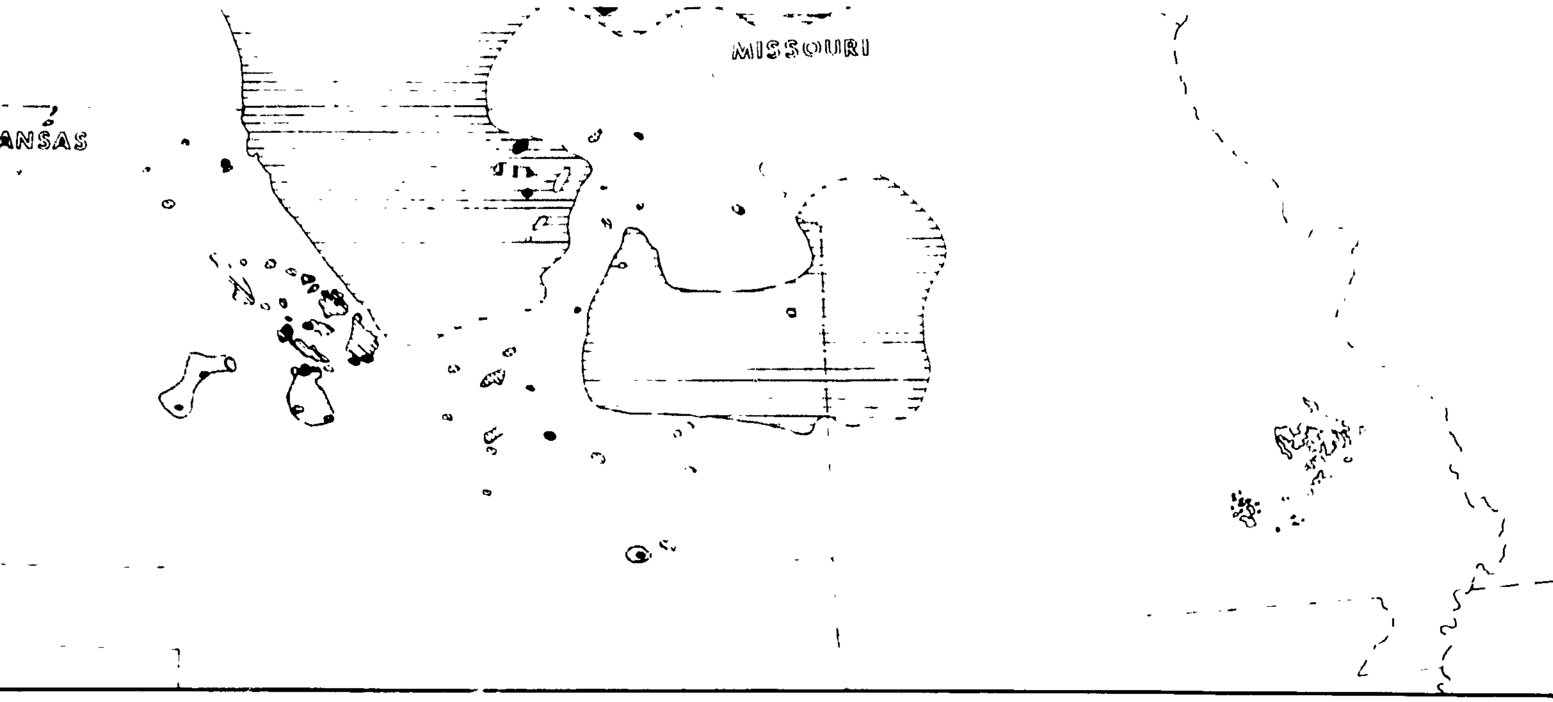
MISS

S DA

SURFACE GEOLOC

TECTON

3



CK TYPES IN THE CENTRAL GREAT PLAINS, CENTRAL INTERIOR AND FRONT RANGE

by James W Skehan SJ

SCALE

25 0 25 50 75 100 MILES

OLOGIES

E AND OTHER INTRUSIVE ROCKS

GNEISS, AND QUARTZITE

ZITE

NTARY ROCKS

SOURCES OF INFORMATION

SUBSURFACE KANSAS MERRIAM, COLE AND HAMBLETON, 1961, P 2020-1.

NEBRASKA (S E) - DATA IN FILES OF KANSAS AND NEBRASKA GEOL SURVEYS

- BULLETIN 4 , NEBRASKA GEOLOGICAL SURVEY.

IOWA - DATA IN FILES OF IOWA GEOLOGICAL SURVEY.

- BULLETIN 4, NEBRASKA GEOLOGICAL SURVEY.

MISSOURI - BULLETIN 4; NEBRASKA GEOLOGICAL SURVEY.

S DAKOTA - REPORT OF INVESTIGATION 88; S. DAKOTA GEOLOGICAL SURVEY.

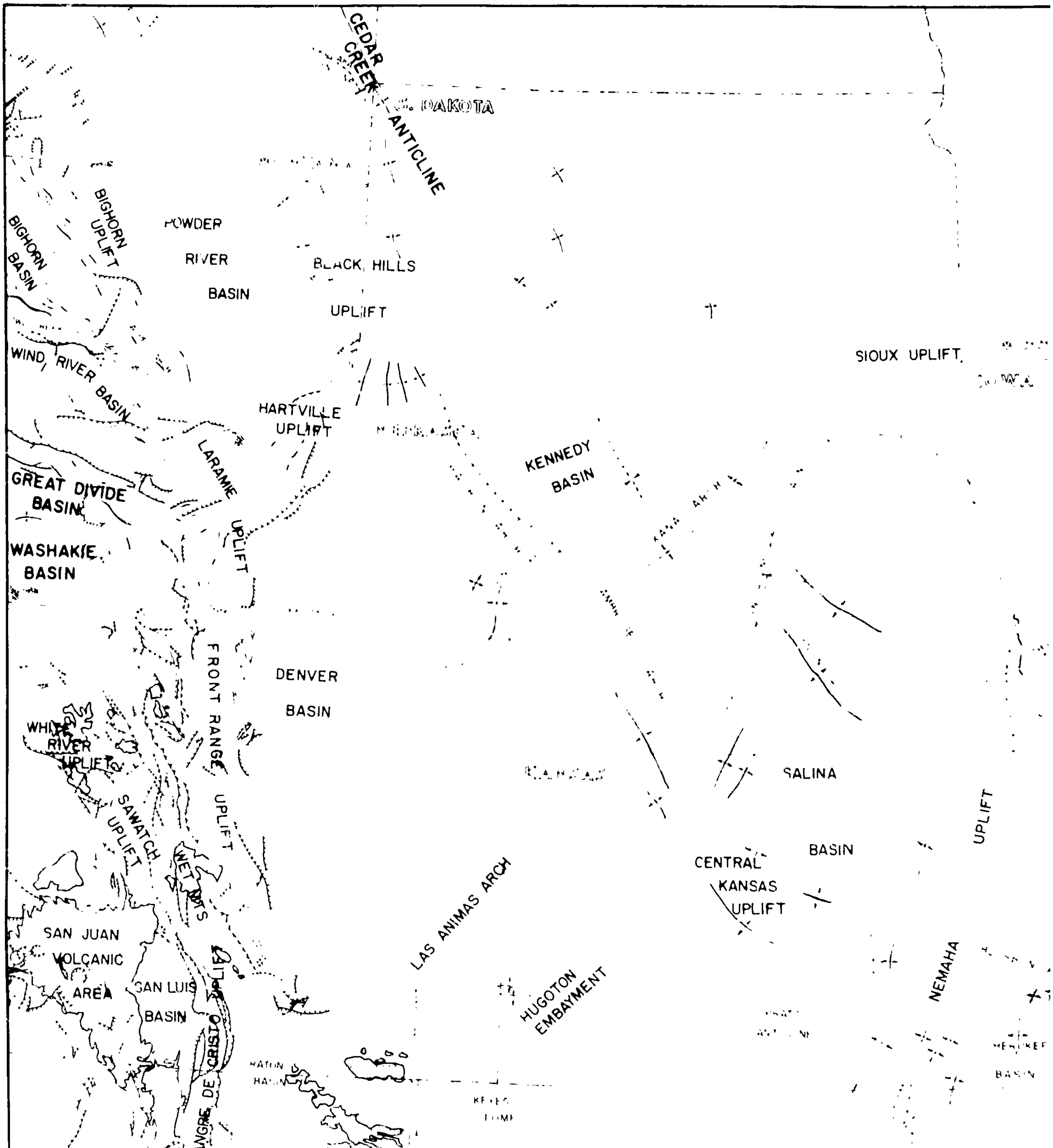
- BULLETIN 4; NEBRASKA GEOLOGICAL SURVEY.

SURFACE GEOLOGIC MAP OF THE UNITED STATES; 1932, UNITED STATES GEOL. SURVEY.

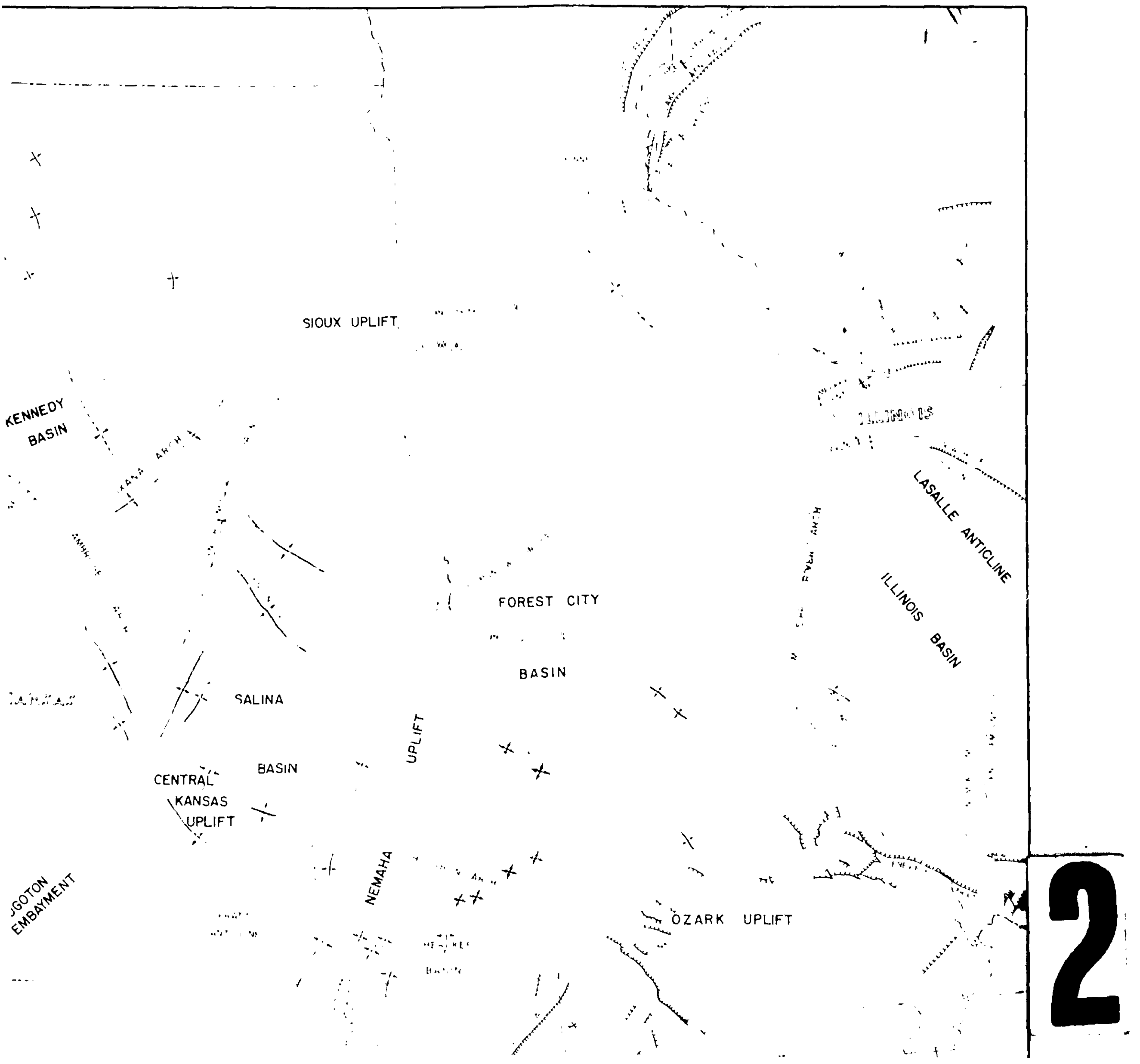
TECTONIC MAP OF THE UNITED STATES; 1962, UNITED STATES GEOL. SURVEY.

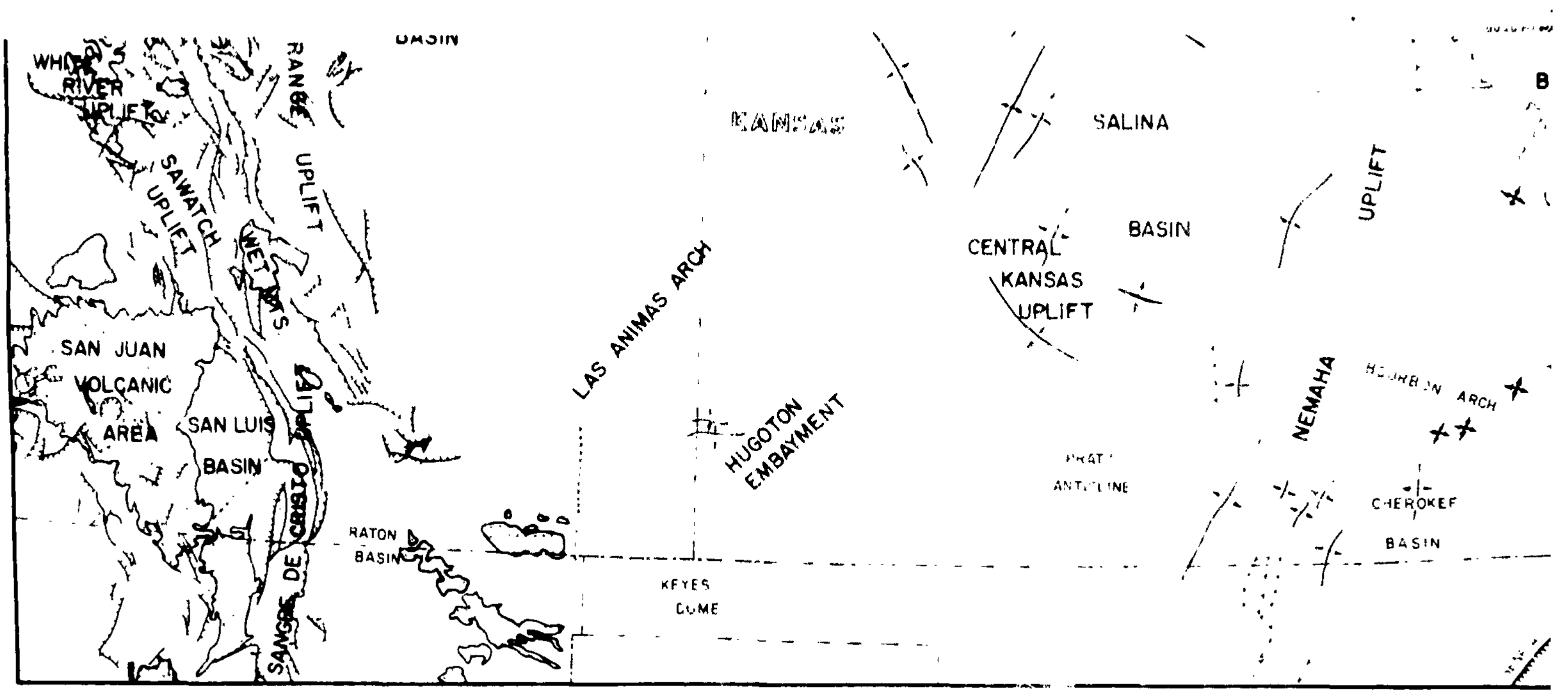
PLATE 2

4


CEDAR CREEK ANTICLINE
S. DAKOTA
BIGHORN BASIN
BIGHORN UPLIFT
POWDER RIVER BASIN
BLACK HILLS UPLIFT
SIOUX UPLIFT
WIND RIVER BASIN
HARTVILLE UPLIFT
LARAMIE UPLIFT
KENNEDY BASIN
GREAT DIVIDE BASIN
WASHAKIE BASIN
FRONT RANGE UPLIFT
DENVER BASIN
WHITE RIVER UPLIFT
SAWATCH UPLIFT
WET MTS
SALINA BASIN
UPLIFT
CENTRAL KANSAS UPLIFT
LAS ANIMAS ARCH
SAN JUAN VOLCANIC AREA
SAN LUIS BASIN
SANGRE DE CRISTO
HUGOTON EMBAYMENT
NEMAHA

1


SIOUX UPLIFT
KENNEDY
BASIN
ILLINOIS
LASALLE ANTICLINE
ILLINOIS BASIN
FOREST CITY
BASIN
SALINA
BASIN
UPLIFT
CENTRAL
KANSAS
UPLIFT
NEMAHA
OZARK UPLIFT
EMBAYMENT
2



TECTONIC MAP OF THE CENTRAL GREAT PLAINS, CENTRAL

by James W Skehan S.J.

SCALE

LEGEND

STRUCTURAL FEATURES

FAULTS (BROKEN LINE INDICATES HYPOTHETICAL FAULTS)

THRUST FAULT (SAW TEETH ON UPTHROWN SIDE)

NORMAL FAULT (HATCHURES ON DOWNTHROWN SIDE)

UNCLASSIFIED FAULT (NATURE OF DISPLACEMENT UNKNOWN)

BURIED FAULTS (INDICATES ALL FAULTS SHOWN ABOVE)

EN ECHELON FAULT SYSTEM (DIRECTION OF DISPLACEMENT NOT SHOWN ON ALL FAULTS OF SYSTEM)

OTHER STRUCTURAL FEATURES

DOME

SYNCLINAL AXIS

ANTICLINAL AXIS (INCLUDES AXES OF BROADLY ARCHED UPLIFTS AND MINOR FOLDS)

ELONGATE, CLOSELY COMPRESSED ANTICLINE (WIDTH OF LINE SUGGESTS HEIGHT, STEEPNESS, OR SIZE OF FOLD)

VOLCANIC AREA

SOURCES OF INFORMATION

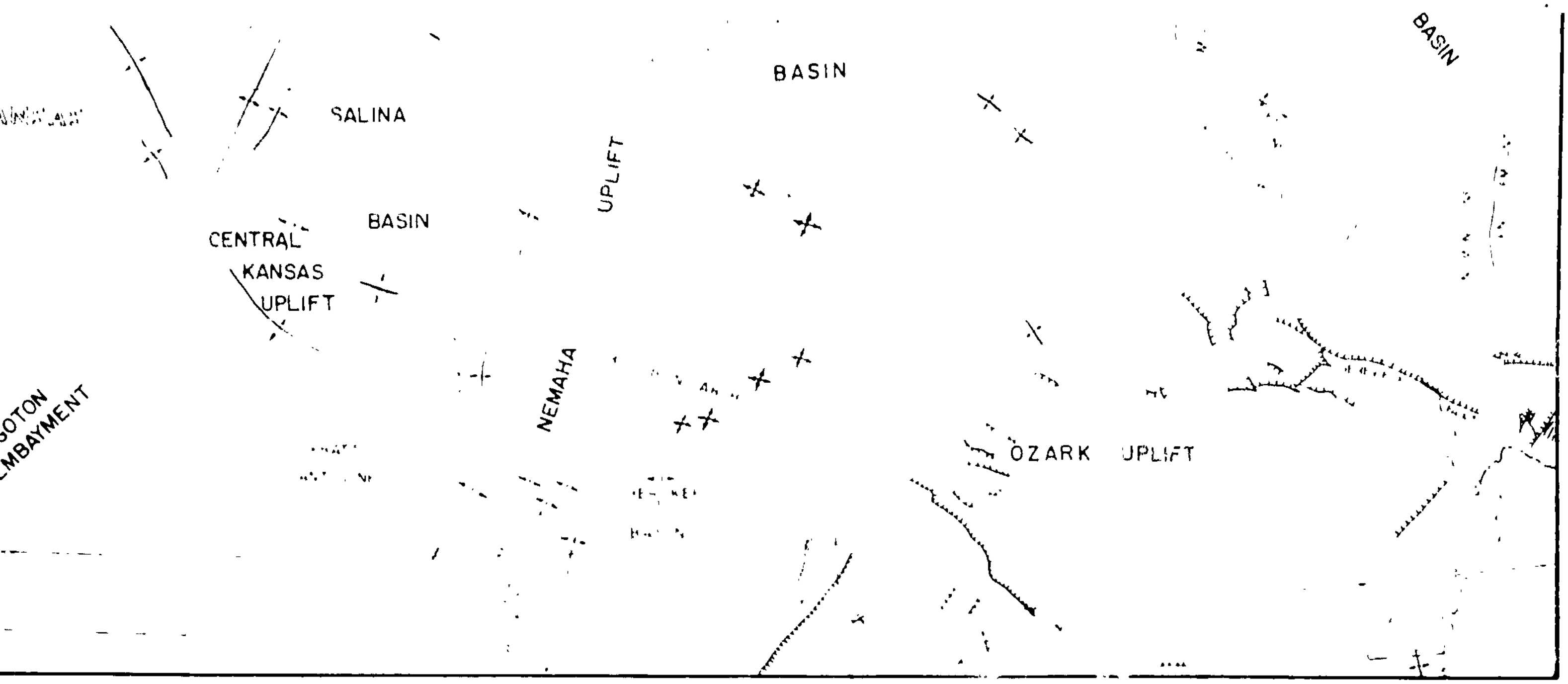
TECTONIC MAP OF THE UNITI

SYMPOSIUM ON GEOPHYSICS OF KANSAS.

GUIDEBOOK. SOUTH-CENTRAL

GUIDEBOOK: SOUTH-CENTRAL

3



NTRAL GREAT PLAINS, CENTRAL INTERIOR AND FRONT RANGE

by James W Skehan SJ

SCALE

SOURCES OF INFORMATION

TECTONIC MAP OF THE UNITED STATES, 1962, UNITED STATES GEOLOGICAL SURVEY

SYMPOSIUM ON GEOPHYSICS IN KANSAS, BULLETIN 137, STATE GEOLOGICAL SURVEY OF KANSAS

GUIDEBOOK SOUTH-CENTRAL COLORADO, 1958, THE KANSAS GEOLOGICAL SOCIETY

GUIDEBOOK SOUTH-CENTRAL KANSAS, 1959, THE KANSAS GEOLOGICAL SOCIETY

UNKNOWN)

ABOVE)

ACEMENT

ARCHED

DTH OF

LD)

PLATE 3

4

FOR ERRATA

AD 414556

THE FOLLOWING PAGES ARE CHANGES

TO BASIC DOCUMENT

GLOSSARY OF GEOLOGIC TERMS

to accompany

GEOLOGY OF THE BASEMENT COMPLEX OF SOUTHEASTERN NEBRASKA, NORTHEASTERN KANSAS AND VICINITY

AFCRL-63-173

James W. Skehan, S.J.
Department of Geology
BOSTON COLLEGE

Glossary of Geologic Terms

(Modified from "Glossary of Geology"
by the American Geological Institute)

anomaly - A deviation from uniformity; a local feature distinguishable in a geophysical, geochemical, or geobotanical measurement over a large area.

anticlinal - A geologic term signifying inclined towards each other, like the ridge tiles of a roof of a house.

aquifer - A formation, group of formations, or part of a formation that is water bearing.

basement complex - A series of rocks generally with complex structure beneath the dominantly sedimentary rocks. In many places they are igneous and metamorphic rocks of either Early or Late Precambrian, but in some places may be much younger, as Paleozoic, Mesozoic, or even Cenozoic.

bedrock - Any solid rock exposed at the surface of the earth or overlain by unconsolidated material.

clastic - Consisting of fragments of rocks or of organic structures that have been moved individually from their places of origin.

complex - Large-scale association of different rocks of complicated structure.

core - The sample of rock obtained through the use of a hollow drilling bit, which cuts and retains a section of the rock penetrated.

cross section - A profile portraying an interpretation of a vertical section of the earth explored by geophysical and/or geological methods.

crust - Material above the Mohorovicic discontinuity.

dip slip - The component of the slip parallel with the fault dip, or its projection on a line in the fault surface perpendicular to the fault strike.

downthrow - The amount of relative movement downward which a faulted block has undergone.

epicenter - The point on the earth's surface directly above the focus of an earthquake.

escarpment - The steep face frequently presented by the abrupt termination of stratified rocks. The escarpment of a mountain range is generally on that side which is nearest the sea.

fault - A fracture or fracture zone along which there has been displacement of the two sides relative to one another parallel to the fracture. This displacement may be a few inches or many miles.

fault block - A mass bounded on at least two opposite sides; it may be elevated or depressed relatively to the adjoining region, or it may be elevated relatively to the region on one side and depressed relatively to that on the other.

fault ridge - A relatively elevated elongated fault block lying between two faults with roughly parallel strike.

feldspar - A group of abundant rock-forming minerals.

formation - The ordinary unit of geologic mapping consisting of a large and persistent stratum of one kind of rock.

geology - A science which treats of the history of the earth and its life especially as recorded in the rocks.

gneiss - A coarse-grained rock in which bands rich in granular minerals alternate with bands in which schistose minerals predominate.

granite - A plutonic rock consisting essentially of alkalic feldspar and quartz. Loosely used for any light-colored, coarse-grained igneous rock.

granite-gneiss - A coarsely crystalline, banded metamorphic rock of granitic composition.

group - A local or provincial subdivision of a series, based on lithologic features. It is usually less than a standard series and contains two or more formations.

igneous - In petrology, formed by solidification from a molten state: said of the rocks of one of the two great classes into which all rocks are divided, and contrasted with sedimentary.

lithology - The physical character of a rock, generally as determined megascopically or with the aid of a low-power magnifier.

loess - A homogeneous, nonstratified, unindurated deposit consisting predominantly of silt, with subordinate amounts of very fine sand and/or clay; a rude vertical parting is common at many places.

mafic - Pertaining to or composed dominantly of the magnesian rock-forming silicates; said of some igneous rocks and their constituent minerals.

member - A division of a formation, generally of distinct lithologic character or of only local extent.

metamorphic - Includes all those rocks which have formed in the solid state in response to pronounced changes of temperature, pressure, and chemical environment, which take place in general, below the shells of weathering and cementation.

metasediments - Partly metamorphosed sedimentary rocks.

phyllite - An argillaceous rock intermediate in metamorphic grade between slate and schist. The mica crystals impart a silky sheen to the surface of cleavage.

quartzite - A granulose metamorphic consisting essentially of quartz. Sandstone cemented by silica which has grown in optical continuity around each fragment.

relief map - A model of an area in which its inequalities of surface are shown in relief.

sandstone - A cemented or otherwise compacted detrital sediment composed predominantly of quartz grains, the grades of the latter being those of sand.

schist - Rocks which have a foliated structure, split up in thin irregular plates, not by regular cleavage.

series - A time-stratigraphic unit ranked next below a system.

strata - Plural of stratum. A section of a formation that consists throughout of approximately the same kind of rock material; may consist of an indefinite number of beds, and a bed may consist of numberless layers; the distinction of bed and layer is not always obvious.

stratified rock - (sedimentary rocks) Derivative or stratified rocks may be fragmental or crystalline; those which have been mechanically formed are all fragmental; those which have been chemically precipitated are generally crystalline, and those composed of organic remains are sometimes partially crystalline.

<u>system</u> - A standard worldwide division; contains rocks formed during a fundamental chronologic unit, a period. Example, Devonian system.

<u>tectonic</u> - Of, or pertaining to, or designating the rock structure and external forms resulting from deformation of the earth's crust.

<u>till plains</u> - Deposits which are formed under ice or where the ice is moving at such a uniform rate that it does not form a hilly accumulation in well defined belts are called till plains or ground moraines. The surface of a broad body of till, commonly having the form of ground moraine with subordinate end moraines.

<u>topographic</u> - An imaginary line on the ground, all points of which are at the same elevation above (or below) a specified datum surface.

GEOLOGICAL TIME SCALE

in millions of years

(After Arthur Holmes, 1960)

	Duration	Millions of years ago to beginning of epoch
Tertiary	70	70 ± 2
Cretaceous	65	135 ± 5
Jurassic	45	180 ± 5
Triassic	45	225 ± 5
Permian	45	270 ± 5
Carboniferous	80	350 ± 10
Devonian	50	400 ± 10
Silurian	40	440 ± 10
Ordovician	60	500 ± 15
Cambrian	100	600 ± 20
Precambrian	?	

CENOZOIC TIME-SCALE

Pleistocene	1	1
Pliocene	10	11
Miocene	14	25
Oligocene	15	40
Eocene	20	60
Paleocene	10	70 ± 2

AD 414556

END CHANGE PAGES